JOHNS HOPKINS HOSPITAL
MAY 20 1918
Library

The Boston Medical and Surgical Journal

TABLE OF CONTENTS

May 16, 1918

ADDRESS

ORIGINAL ARTICLES

BOOK REVIEW

EDITORIALS

CORRESPONDENCE

MISCELLANY

Address.

TRAUMATIC SHOCK.*

BY W. T. PORTER, M.D., BOSTON.

THE history of traumatic shock during the past thirty years has been marked by hypotheses that have caused much confusion. These hypotheses give as the cause of shock: (1) the exhaustion of the vasomotor center, (2) the excitation of sensory nerves, (3) a hydrostatic fall in blood pressure, (4) vibration injuries, (5) direct wounds of the vasomotor apparatus, (6) hemorrhage. Some of these ideas are erroneous; others are imperfectly grasped.

The exhaustion of the vasomotor center cannot be the cause of shock because the center does not become exhausted.[1] In shock it still reacts to the stimulation of the depressor nerve. The fall in blood pressure is great enough to prove that the vasomotor center is not significantly impaired. If the blood pressure remains below the nutrient level for many hours, even the resistant vasomotor center suffers, like all other tissues, though the vasomotor center shows a surprising vitality. But the result of prolonged shock is not to be confused with its cause.

Excitation of sensory nerves is not the cause of shock, because the sensory nerves in normal animals may be strongly stimulated for many hours without producing a noteworthy fall in blood pressure.[2]

The confusion of thought that led to the hypothesis of shock from irritation of the nerves rests partly on the mistaken ideas that wounds are acutely painful, and that pain *per se* is followed by shock. Wounds are rarely very painful, and shock is seldom preceded by excessive pain.

It is true that a condition roughly resembling shock has occasionally followed an injury to a nerve during an operation. This condition is not shock, but a prolonged inhibition of the heart.

It is naturally surprising that a stimulus to a nerve, ordinarily innocent, should in such instances call forth strange results. The explanation is that the patient is in a state for which I propose the name *sensitization*. This conception, which is new, rests on experimental evi-

* Remarks by invitation before the Boston Surgical Society, Incorporated, at its twentieth stated meeting held at the Harvard Club of Boston, December 3, 1917.

dence. Examples follow: (1) In 50% of dogs given morphine and curare, ligation of the ramus descendens of the left coronary artery produced fatal fibrillation of the heart, whereas fibrillation very rarely occurred when ether alone was used.[3] (2) In a rat to whom morphine and curare were given, gently lifting the sciatic nerve on a thread caused inhibition of the heart, lasting over half an hour.[4] (3) In the tortoise heart, a stimulus which ordinarily caused a tonus contraction lasting 30 seconds, caused in this case a contraction lasting 64 minutes.[5]

Since the heart is a modified blood vessel, the sensitization of the heart would lead us to expect sensitization of the arteries. I have at present no experimental evidence of this. Yet there is some clinical evidence of prolonged contraction or relaxation of the blood vessels following stimuli ordinarily uneventful. Such is the tonic arterial contraction in certain migraines, and the long relaxations in urticaria. But the evidence in hand, unquestionable for sensitization of the heart, does not as yet warrant including sensitization of the arteries among the sources of confusion in shock.

A simple hydrostatic fall of blood pressure is not shock. When the intestines are exposed, the largest vascular area in the body dilates and the arterial pressure falls. If this low pressure continues long enough to impair the nutrition of the vascular apparatus, shock may occur. An admirable example of the hydrostatic fall of blood pressure is seen when a spinal injection of novocaine reaches the splanchnic nerve cells. The arterial pressure falls to the shock level, but the fall is usually too transitory to cause shock.[6]

Vibration injuries may cause shock when the vibration, as in certain railway cases, shakes the vasomotor cells until their function is impaired. The blood pressure then falls, and if the vibration has been sufficiently severe, the classical symptoms of shock will soon appear. If the injury affects only the lower half of the spinal cord, the vessels of the lower extremities may be dilated for several days, but this vascular area is too small to lower greatly the general blood pressure, and shock does not take place.

Wounds of the vasomotor paths from shell fragments have been observed in this war. If in the abdomen, the interruption to the tonic constrictor impulses is serious. Hydrostatic shock may follow.

That hemorrhage is not usually a cause of shock is proved by the simplest reflection. In the present war, shock occurs once in every hundred casualties. Sometimes the shock case bleeds freely, sometimes not. But practically always, in the other 99 cases, who do not have shock, there will be men who have lost more blood than the shock case.

The idea that hemorrhage is a frequent cause of shock rests on the unquestioned fact that on the operating table the loss of a small quantity of blood is sometimes followed by shock. The explanation is that the blood pressure was near the *critical level* and that the loss of a small quantity of blood carried the pressure below the critical level. Ordinarily, the loss of from 500 to 1000 cc. of blood may leave the pressure still on the safe side of this level.

The critical level of blood pressure is that point below which the blood pressure will not usually rise again without assistance. With the Vaquez instruments used by me in France, the normal diastolic pressure was 97 and the critical level about 60, *i.e.*, between two-thirds and three-fifths of the normal. Certainly the normal diastolic pressure varies with the instrument employed. It is possible that the critical level shows a similar variation.

An understanding of the critical level is of the first importance in the study and treatment of shock. If the blood pressure just touches the critical level, a difference of ten millimeters of mercury may be the difference between life and death. A few millimeters above this level, recovery will usually occur spontaneously; a few millimeters below, death will follow unless skilled aid be at hand. It follows from this vital fact: (1) that procedures which at ordinary blood pressures are not harmful, or are but slightly harmful, may kill the patient at the critical level; (2) remedies that raise the blood pressure but ten or fifteen millimeters will save the patient when this rise carries the blood pressure from just below to just above the critical level.

The critical level varies with the condition of the nerve cells and other tissues. A blood pressure high enough to maintain a sufficient nutrition in normal bulbar nerve cells is too low to maintain life in cells that have already suffered from malnutrition. In that case a blood pressure raised by the surgeon to a point

above the usual critical level will shortly sink again. Hence the importance of frequent readings of the blood pressure until shock patients are clearly out of all danger. Treatment not based on repeated readings of the blood pressure is not intelligent, and may be harmful.

The diastolic blood pressure should be employed in shock. In this condition, the heart beats feebly. The systolic pressure falls more than the diastolic pressure falls. Conversely, when remedies are used, they often raise the systolic pressure more than they raise the diastolic pressure. Conclusions drawn from the systolic pressure may easily err 15 millimeters or more. But in shock, the blood pressure is at a critical level; a change of even 15 millimeters may be a matter of life or death. The error in using the systolic instead of the diastolic pressure may, therefore, do much harm.

In the summer of 1916, during my service in the fighting line in France, I learned that in this war, shock occurs chiefly after shell fractures of the femur and after multiple wounds through the subcutaneous fat. In 1000 casualties, observed by me at the Massif de Moronvillers, these were the only injuries producing shock, except certain abdominal wounds in which the shell fragments undoubtedly disturbed the apparatus of the largest vascular area in the body.

It has long been known that fat embolism takes place after fractures of the thigh and after multiple wounds through the subcutaneous fat.

In February, 1917, I proved that the injection of a small quantity of neutral olive oil in the jugular vein was followed by a falling blood pressure and the other symptoms of traumatic shock. The resulting publication was the first clear statement that shock as seen on the battlefield is frequently caused by fat embolism.[7]

Shortly thereafter I developed a new remedy for the treatment of shock. It has long been known that the pumping action of the diaphragm is an important aid in the movement of blood from the abdomen into the chest. At the height of a strong inspiration the venous pressure in the chest may be more than 40 millimeters lower than the venous pressure in the abdomen. I produced strong respiratory movements of the diaphragm by allowing the animal to breathe an atmosphere rich in carbon dioxide. The diastolic arterial pressure was thereby increased 15 and even 30 millimeters.[8]

In June, 1917, at the Chemin des Dames, I successfully applied this new method to the treatment of wounded soldiers. In cases almost pulseless—cases in which all other means of raising the blood pressure had failed—the carbon dioxide respiration strengthened the pulse and raised the diastolic blood pressure 10 millimeters.[9] This rise is of great value when the pressure is at the critical level.

The general treatment employed by me at the Chemin des Dames was as follows: A shock room was made next the operating room. The patient was carried to the shock room directly from the ambulance. He was not washed. He was at once placed on an operating table, inclined so that the feet were 30 cm. higher than the head. An electric heater was put between the blankets and the body. The diastolic pressure was taken every 15 minutes. Where indicated, injections of warm normal saline solution were made into a vein. If his state was grave, adrenalin was added to the saline solution. Carbon dioxide respiration was used. When his condition justified operation, the clothing was cut away about the wound and the area disinfected. Neighboring regions were covered with sterile cloths. He was then moved, still in the inclined position and still on his hot table, to the operating room. The operation was done under local anesthesia, whenever possible. At its close, the patient was wheeled back to the shock room, still on the same inclined hot table. I did not leave him until he was out of danger or dead. Repeated readings of the pressure were taken. The remedies were directed to raising the diastolic pressure to a point about 15 millimeters above the critical level—more is not necessary. One case was operated on during the carbon dioxide breathing, with apparent advantage.

Under these methods four-fifths of the patients recovered.

A word as to details may be of interest. Normal saline solution should be injected at 39° C., measured by a thermometer in the vertical limb of a ⊥ tube placed next the cannula. If the pressure has not remained too long below the critical level, it will be raised by the normal saline; otherwise not, because the permeability of the vessel walls is increased by prolonged low pressures. Prof. Bayliss states that the addition of 5% of gum arabic to the saline solution will prevent leakage and thus raise the pressure under all circumstances. This sug-

gestion was made after my leaving France, and I have had no personal experience of its value.

Adrenalin is of temporary advantage, but even this fleeting rise of blood pressure may save life. In the laboratory, the blood pressure of animals may be raised for considerable periods by allowing the well-diluted adrenalin to flow into the vein drop by drop from a burette. I have not tried this on men.

Dr. Meltzer very recently stated that the pressor action of epinephrin is much prolonged when the drug is injected into the vertebral canal.

The carbon dioxide respiration should not be stopped too abruptly.

REFERENCES.

[1] Porter, W. T., and Quinby, W. C.: Am. Jour. of Physiol., 1908, Vol. xx, p. 500.
[2] Porter, W. T., Marks, H. K., and Swift, J. B., Jr.: Am. Jour. of Physiol., 1907, Vol. xx, p. 444.
[3] Porter, W. T.: Jour. Exp. Med., 1896, Vol. i, p. 49; and Arch. f. d. ges. Physiol., 1893, Vol. lv, p. 366.
[4] Porter, W. T.: Harvey Lectures, 1906-1907, pp. 113 and 114.
[5] Porter, W. T.: Am. Jour. of Phys., 1905, Vol. xv, p. 9.
[6] Porter, W. T., and Smith, G. G.: Am. Jour. of Phys., 1915, Vol. xxxviii, p. 108.
[7] Porter, W. T.: BOSTON MEDICAL AND SURGICAL JOURNAL, 1917, clxxvi, p. 248.
[8] Porter, W. T.: *Ibid.*, p. 699.
[9] Porter, W. T.: *Ibid.*, 1917, Vol. clxxvii, p. 326.

BETH ISRAEL HOSPITAL.—The Beth Israel Hospital has undergone a change of management. The executive committee, including Dr. K. M. Davidson, Dr. Albert Ehrenfried, Dr. Harry Linenthal, and Dr. Louis M. Friedman, are now reorganizing the medical board. Committees have been appointed to procure the services of a competent physician as superintendent and to conduct a campaign for new membership. This hospital is now being conducted on the Kosher basis.

Original Articles.

THE ANATOMY AND PHYSIOLOGY OF THE RESPIRATORY TRACT.*

BY FRANK F. D. RECKORD, M.D., HARRISBURG, PA.,

Deputy Medical Inspector of Tuberculosis Dispensaries, Pennsylvania State Department of Health.

THE ANATOMY OF THE RESPIRATORY TRACT.

THE respiratory tract develops as an outgrowth of the primary digestive tube, and consists of air passages—nasal fossae, pharynx, larynx, trachea and bronchial tubes—and organs of special function—the lungs, which correspond in structure and development to racemose glands.

The larynx consists of a number of cartilages which by their relative changes of position modify the approximation and tension of two folds of mucous membrane over fibrous tissue, known as the vocal cords, on either side of the cleft through which the air enters the windpipe. The larynx is in the neck, being suspended from the hyoid bone and leading to the trachea. It is practically subcutaneous in front. Its superior orifice is behind the base of the tongue, and can be seen in life only by a mirror. The cartilages are connected by joints and ligaments, moved by muscles, and covered by mucous membrane, the folds of which form important morphological parts of the larynx.

The trachea (10 to 12 cm. long and 11 to 18 mm. wide) is kept patent by horizontal cartilaginous rings embedded in its wall, but which are deficient posteriorly, where it is consequently flattened. It begins as the lower border of the cricoid cartilage opposite the lower margin of the 6th cervical vertebra and extends beneath the thyroid, through the suprasternal region and jugular fossa of the superior mediastinum, ending at the junction of the manubrium and gladiolus and the level of the upper border of the 5th dorsal vertebra. It follows the median line to its lower end, which is slightly to the right, lying upon the esophagus and following with it the curve of the vertebral column, passing behind the thyroid plexus, manubrium, left innominate vein, innominate artery and part of the left common carotid. There is a slight expansion about its middle and at the bifurcation, which is held in fixed position, the remainder having considerable mobility.

The mucosa is lined by stratified ciliated columnar epithelium containing goblet cells. The tunica propria consists of a loose inner fibrous layer and an outer network of longitudinal elastic fibers. The submucosa, containing small groups of mucous glands, loosely connects the mucosa with the fibrous sheath, which forms a complete investment.

The bronchi are formed by the bifurcation of the trachea, which they leave at right angles to each other. The right is shorter and broader than the left, and takes a more vertical course and its first collateral branch arises much nearer to the trachea. Each passes outward and downward to the hilus of the lung, where it

* From a Post-Graduate Course of Instruction for the Medical Staff of the Pennsylvania State Tuberculosis Dispensaries.

subdivides into its ramifications, which extend down into the lowest lateral part of the lungs.

The structure repeats almost exactly that of the trachea, with such modifications as result from the slighter general development of the coats incident to the gradual reduction in the size of the tubes.

The lungs are a pair of conical organs, each developed in a serous membrane—the pleura—occupying the greater part of the cavity of the thorax, and separated from each other by the contents of the mediastinum. Although in general conical, the lung differs in many respects from a true cone. The base is concave, moulded over the convexity of the diaphragm, and descending further at the back and side than at the front and internally. The apex is not over the middle of the base, but much to the inner and posterior side of it, so that the back and inner side of the lung descend much more directly than the rest.

The right lung is the larger on account of the greater encroachment of the heart on the left. Its apex rises from one inch to one and three quarters inches above the level of the clavicle. It differs from the apex of the left lung in that it lies close to the trachea, while the apex of the left lung is separated from the trachea by the great blood vessels springing from the arch of the aorta. The anterior border runs downward, forward and inward—passing nearly behind the right costo-sternal articulation to the mid-sternal line at the level of the second rib. From this point it runs vertically downward to the level of the sixth chondro-sternal articulation, where it turns sharply to the right and becomes the lower border. The lower border bears relation to the sixth rib in front; side, eighth rib; back, tenth rib. The lobes are three in number, produced by deep fissures. The upper and lower lobes are separated by a fissure starting at the spinal column, level with the spine of the scapula. This runs outward, downward and forward to the fourth rib in the axillary line, where it divides into two secondary fissures. The upper runs forward horizontally, reaches the anterior border of lung at the fourth rib. The lower fissure passes downward and forward to the lower border of the lung in the mammillary line. These fissures bound the middle lobe.

In the left lung the apex is separated from the trachea by the great blood vessels, esophagus, areolar, and lymphoid tissue. The anterior border lies farther from mid-sternal line; at level of fourth rib it curves outward, downward, and then moderately inward to the sixth rib, exposing a semi-circular area of the pericardium (superficial or exposed cardiac dullness). The lower border runs outward and around to the spinal column similar to that of the right. The lobes are two in number,—the upper and lower, separated by a fissure which, instead of bifurcating as in the right side, passes downward and forward, to end at the sixth rib in the left mammillary line.

Both upper lobes extend as far as the spine of the scapula posteriorly; below this are the lower lobes. Anteriorly the lobes bear the following relations: right side, upper lobe as far down as fourth rib; middle lobe from fourth to sixth ribs; on left side, upper lobe alone. Laterally, right side, in the mid-axillary line is the upper lobe and the beginning of the middle and lower lobes. Laterally, left side, in the mid-axillary line, upper and lower lobes.

It is the superior or upper lobe on both sides that contains the apex and the lower or inferior lobe which has the base or the broad concave surface.

The volume of the upper and lower lobes of the left lung is about equal. In the right lung, that of the inferior is about equal to that of the other two. We consider the middle lobe simply as a piece cut off from the upper, so that the right upper and middle lobes correspond to the left upper lobe.

The roots of the lungs consist of the bronchi, the right one giving off a branch before entering the lung; the pulmonary artery and vein; the bronchial arteries and veins, the lymphatic vessels and nodes and the nerves.

Louis' angle (the junction of the manubrium with the gladiolus) marks the sternal attachment of the second rib. It is opposite to the level of the fifth thoracic vertebra, indicates the level at which the trachea bifurcates, and anteriorly the upper point at which the lungs meet, to diverge again at the fourth costal cartilage. It marks the upper boundary of the cardiac auricles, and the point at which the veins of the hand collapse while the arm is being raised upward from its lowest to its highest position (Gaertner's test of venous blood pressure). It forms a convenient landmark from which to count ribs.

The percussion note from the right upper apex to the second interspace is slightly higher

pitched, less resonant, and at times has a slightly tympanitic quality because: (1) The right apex is smaller. (2) The superior vena cava lies in front of the inner part of it. (3) The right subclavian artery occupies a more anterior, the left a more mesial, position. These conditions account for the diminished resonance and higher pitch. The right apex lies in immediate contact with the trachea. This accounts for the tympanitic element (and in part for the elevation of pitch. (4) A slight influence—with light percussion—is sometimes exercised by the increasing thickness of the right pectoral muscles.

Pleurae. The pleurae are a pair of serous membranes disposed one over each lung and then reflected so as to line the walls of the cavity containing it, thus forming a distinct closed sac about each lung; hence the pleura is divided into a visceral and a parietal layer. The latter is subdivided according to its situation into a mediastinal, a costal, a cervical and a diaphragmatic part.

The visceral layer closely invests the lungs, following the surface into the depths of the fissures. It leaves the lung at the borders of the hilum and invests the root for a short distance, when it leaves the latter and spreads out as the mediasinal pleura, which is applied, back to back, to the pericardium, thus forming on each side a vertical antero-posterior septum between the lungs and the contents of the mediastina.

The pleural sacs extend below the lower border of the lungs to a considerable extent in the mammillary line. They lie 2 inches below in midaxillary line, $3\frac{1}{2}$ inches in the scapular line, $1\frac{1}{2}$ inches lower than the edges of the lungs.

Lobules of the Lung. W. S. Miller found that the last branch of the bronchus before breaking up in the parenchyma of the lung becomes somewhat dilated at its distal extremity. Connected with this expansion of the terminal bronchus there are from three to six nearly spherical cavities—the atria. Each atrium communicates, on the one hand, by means of a nearly circular opening with the terminal bronchus; on the other hand, by semilunar shaped openings, with a variable number of larger and more irregular-shaped cavities (air sacs) which have small projections from their surface (alveoli, air cells). From this description it will be seen that the air sacs do not communicate directly with the terminal bronchus, as is usually described, but between each air sac and terminal bronchus there is interposed a cavity, which is constant in all parts of the lung, viz., the atrium.

Thus the atrium is smaller than the air sacs and, like the terminal bronchus, the air sac has numerous air cells projecting from its surface. In structure the walls of the atrium resemble that of the air sacs.

The above portion of lung structure, Miller considers the lung unit, to which he has assigned the term, "primary lobule"; while to an aggregation of primary lobules which is marked out by well-defined connective tissue septa, together with the blood vessels, lymph vessels and nerves associated with the above-defined aggregation, he gives the name of "secondary lobule."

Piersol agrees with Miller that the portion which he has called the primary lobule is the lung unit, but prefers the term "lobule" to be associated with this aggregation of units which Miller calls the secondary lobule.

The Blood Vessels and Lymphatics of the Lungs. The pulmonary artery serves not for the nutrition of the lung, but for the aeration of the blood. An intralobular branch enters each lobule near the apex with the bronchus and follows its ramifications until the ultimate bronchi have ended in the air-chambers of the lung unit.

The pulmonary veins return the aerated blood to the left auricle. They arise from the capillaries in the walls of the air-chambers, running first on the outside of the lung units, uniting with others, and ramifying the connective tissue about the lobules. Thus the circulation is from the center toward the periphery.

The bronchial arteries carry the blood for the nutrition of the lungs, especially that of the air tubes, the lymph nodes, the walls of the blood vessels, and the areolar tissue about them.

The lymphatics of the lungs may be divided into a superficial and deep set. Lymphoid tissue is situated in the peripheral portion of the lung and also in the pleura. Passing toward the hilum we have the pulmonary lymph nodes, and at the hilum the various bronchial groups

The flow of the lymph, according to Miller, in the lymphatics of the bronchi, arteries, the main venous trunks, and the greater part of the pleura, is toward the hilum of the lung. In the lymphatics about the veins, the flow,

especially in those beneath the pleura, and communicating with the pleural network of lymphatics, may be toward the pleura.

PHYSIOLOGY OF THE RESPIRATORY TRACT.

Respiration is used to express respiratory movement and, secondly, the interchange of oxygen and carbon dioxid. By means of the respiratory movements we have an inflow and outflow of air to and from the lungs. The object is to supply the body with the necessary oxygen for its oxidation processes and to remove the carbon dioxid resulting from combustion. External respiration consists in the interchange between gases of the outer air and those of the blood contained in the lungs and skin, while the internal, or tissue respiration, is the exchange of gases between the capillary blood and the body tissues.

The organs of external respiration consist of the lungs and upper air passages; pleurae; muscles of inspiration and expiration; nerves, consisting of the vagus, sympathetic, intercostals, phrenic and others; the respiratory center which is located in the medulla and subsidiary centers in the cord; pulmonary blood vessels.

Any condition which will, in any way, alter the normal action of any of the above structures will produce a change in the external respiration and indirectly affect the internal interchange. Still more indirectly will it affect the metabolism of the body and the various functions performed. Thus it matters not whether the disturbance is with the heart, which fails to maintain the circulation through the lungs, with the air passages not permitting sufficient amount of air to enter the air sacs, or a paralysis of a phrenic nerve, inhibiting the action of the diaphragm; the gaseous exchange is interfered with in each instance, the effect depending upon the nature and severity of the lesions.

Therefore the normal respiration depends upon the condition of the lungs and the upper air passages; the respiratory movements; the action of the heart; the condition of the blood and blood vessels; and the character of the air breathed.

The functions of the upper air passages are: (1) to transmit air to and from the lungs; (2) to warm the air; (3) to filter the inspired air; (4) to furnish a place for the peripheral endings of the nerves of smell; (5) to protect the lungs from foreign particles by reflex action on account of the stimulation of the different endings in the mucous membrane. The mucus secreted by the glands in the mucous membrane of the respiratory tract arrests dust particles and other foreign bodies in the inspired air, and the ciliated epithelial cells keep the lungs clear of accumulations of mucus and the suspended dirt particles. The squamous cells lining the air vesicles, by virtue of their vital activity, play a part in the exchange of the respiratory gases.

The mechanism of respiration consists in the alternating dilatation and contraction of the thoracic cage; the dilatation is termed "inspiration" and the contraction is called "expiration." The lungs lie wholly passive within the thoracic cavity, and by virtue of their complete elasticity follow every change in the capacity and shape of the thorax. Enlargement of the thorax is affected by certain muscles known as the muscles of inspiration; the diaphragm descends and at the same time is withdrawn from the chest walls; the ribs are elevated and rotated outward. At the end of inspiration the muscles relax and the thorax collapses, expiration being usually a passive process due to the elasticity of the lungs, the weight of the chest, the tension of the abdominal muscles, and the torsion of the costal cartilages. It is also assisted to some extent by the action of the muscles of expiration. The respiratory movements are controlled by a center in the medulla.

The lungs are in the nature of two large bags which are honeycombed with saccular pouches or alveoli. Owing to this, the total surface exposed by these air vesicles is equal to 200 square meters. This surface is from 100 to 130 times greater than the surface of the body. These air vesicles are covered by a dense capillary plexus, and so dense is this that the air vesicles are literally covered by a film of blood. The lungs are highly elastic, always under normal conditions they are somewhat stretched or inflated. At birth the lungs do not contain any air; but, after respiration has once started, there is never any absence of air.

The importance of knowing the amount of air space within the air sacs and air passages is quite evident in many conditions where the amount of air taken in and given off seems to be much diminished. In these conditions the spirometer is of value and will best show the tidal air, by which is meant the volume respired during each quiet respiratory movement, amounting to 300 cc., or 18 cubic inches.

The complemental air is the volume of air inspired after completion of ordinary inspiration, and amounts to 1700 cc., or 104 cubic inches. After you have performed a quiet expiratory act you can force from the lungs a large volume of air, called "reserve" or "supplemental" air, which is equivalent to 1500 cc., or 91 cubic inches. After you have thus forcibly driven all air from the lungs that is possible, a considerable amount remains in the lungs. Thus the volume of air remaining in the lungs after a forced expiration is called "residual air," and is equal to 1000 cc., or 61 cubic inches. Therefore, the vital capacity of the lungs is the volume of air which can be expired after forced inspiration. It includes the tidal, complemental, reserve, and residual airs, and amounts to 4000 to 4500 cc. It varies with age, stature, posture, occupation, clothing and state of the stomach.

Atmospheric pressure is exerted upon the veins in the neck and externally upon the vena cava in the abdomen, while in both cases the pressure in the thorax upon the extensions of these vessels is less. At each inspiration, therefore, the blood is rapidly forced from these veins into the heart. The atmospheric pressure equals 760 mm. of mercury, or about 15 pounds to the square inch.

The intrathoracic pressure is the pressure in the thoracic cavity outside of the lungs. It is the pressure exerted upon the heart and the great vessels in the chest.

The intrapulmonic pressure is the pressure in the interior of the lungs. During inspiration, intrapulmonic pressure falls below the atmospheric pressure. If the air passages are obstructed, as in asthma, edema of the glottis or a cold in the head, there is a fall of pressure in the lung during inspiration. When the glottis is closed inspiration and expiration give greater rise and fall. Emphysema results from the increased intrathoracic pressure, the least supported, or weak parts, giving way first.

The normal respiratory rate per minute in the newborn is 44; from 1 to 5 years, 26; 15 to 20 years, 20; 20 to 25 years, 18.7; 25 to 30 years, 16; 30 years, 15.1.

In disease the respiration rate may be increased or diminished.

a. Rapid respiration—may exist without the presence of difficult or laborious breathing. It may be due to muscular exertion, mental excitement, fever, by the influence of heated blood upon the medulla, lobar pneumonia, hysteria.

b. Slow respiration—found in many of the varieties of coma, collapse, and by poisoning with aconite, antimony, chloral, chloroform and opium.

The term "eupnea" is applied to easy breathing. In this the chief point of distinction is that expiration is entirely passive. Quiet breathing is mainly diaphragmatic or abdominal. We speak of the types of breathing as either "costal" or "abdominal," implying that these respective parts are seen to act more strongly.

The thoracic type predominating is found normally in women at or after the age of puberty. Costal breathing in a man or its presence to excess in a woman is indicative either of dyspnea, real or subjective, or of some condition limiting the mobility of the diaphragm, abdominal respiration depending upon the full and free action of the latter.

Excessive upper costal or diminished abdominal breathing may be caused by pressure upon the diaphragm, ascites, meteorism, or abdominal tumors or enlargements; large pericardial effusion, inflammation of the diaphragmatic pleura or peritoneum, paralysis of the diaphragm, emphysema. Finally, the marked costal breathing of the hysterical patient is familiar.

The abdominal type predominating is found in children of both sexes and the adult male. If this type is exaggerated in a man, or is present together with diminished or absent thoracic breathing in a woman, it is abnormal.

Causes. Found in conditions which render movements of the thorax painful, such as pleurisy, pleurodynia, fracture of rib, double pleural effusion, calcification of the costal cartilages, emphysema, the rare scleroderma of the chest wall and ossifying myositis; may also be due to paralysis of the muscles of inspiration, as in injury or disease of the cervical portion of the spinal cord or bulbar paralysis, or spasm of the same muscles in strychnine poisoning or tetanus.

Respiratory movements of the thorax should be investigated by inspection, palpation and mensuration. Inspect chest in a good light from the front, side, back and from above—watching carefully for defective or excessive motion, general or local.

The natural type shows the movement fairly well balanced—abdominal in excess. The extreme costal type is somewhat different from the others in that there is a marked outward movement of the costal portion of the thorax and movement inward of the abdominal walls. In this type we find the most effective force to get blood back to the heart.

NERVOUS MECHANISM OF THE RESPIRATORY MOVEMENTS.

The nervous mechanism required to initiate and regulate the coördinated action of the numerous muscles which execute the respiratory movements consist of a respiratory center, with afferent and efferent nerves. The respiratory center lies in the medulla, and is divided into unilateral halves, so closely connected as to perform functionally as a single center. The right half is connected with the respiratory musculature of the same side and *vice versa.* Each half is sensorially connected with both sides of the body.

No sensory impulses are generated in the lungs under normal conditions except those generated in inflation which inhibits the discharge of impulses from the center.

The power of rhythmic action is inherent in the nerve cells of the center, but it requires a continuous excitation, which is supplied by the carbon dioxid and other substances in the circulating blood.

Deficient Expansion. This may be general, affecting the thorax as a whole, or localized on one side or a portion of the chest. A general poor expansion may be due to the limiting effect of the chest pain incident to pleurisy, pneumonia, pleurodynia, fractured ribs, angina pectoris and intercostal neuralgia, obstructed upper air passages, as in pressure on the trachea (mediastinal tumors or aneurysm), laryngeal stenosis, tumor, paralysis or spasm, paralysis or tetanic spasm of the respiratory muscles, asthma and emphysema, the lungs being distended to an extent which will permit but slight additional expansion. Shallow breathing may be simply a part of the general muscular weakness of adynamic conditions, *e.g.*, collapse, syncope, or the typhoid state in general.

Unilateral deficiency of expansion is indicative of some diseased condition which prevents inflation of the corresponding lung. It is a diagnostic symptom of importance, and may find its explanation in a mechanical hindrance to expansion upon one side by the presence of fluid or air in the pleura or extensive pleural adhesions, or on the right side by an enlarged liver; in obstruction in the main bronchus by foreign body or the pressure of an aneurysm or tumor, or in disease confined to one lung—tuberculous, fibroid, pneumonic, cancerous, hydatid or atelectatic.

A local deficiency in expansion or a lagging of one portion of the chest wall behind the remainder during inspiration is suggestive of circumscribed disease of the lung or pleura. Deficient expansion under the clavicle is seen in tuberculosis; of the upper or lower portion of the thorax, in apical or basal pneumonia; of the pericardial space in pericardial adhesions, of various localities with pleural adhesions, and especially in the child in local atelectasis, or collapse of the lung.

Increased general expansion occurs after exercise or mental excitement and in hysteria and some forms of dyspnea. Local or unilateral increase of expansion may be compensatory.

Retraction of the interspaces is usually associated with deficient expansion and inspiratory dyspnea. General retraction is most marked in obstruction of the upper air passages and extensive bilateral broncho-pneumonia in children. Unilateral or local recession indicates obstruction of the bronchus or circumscribed interference with expansion as in pulmonary collapse of infants, the affected portion not distending, pleuritic adhesions and other similar conditions. *Bulging during inspiration* is seen only above the clavicles, and is an evidence of emphysema, the apex of the hypertrophied lung protruding above its normal level.

LITTEN'S PHENOMENON.

The existence of the moving shadow of the diaphragm in the axilla, with patient supine, feet to the light, is due to the fact that, at the end of expiration, the lower portion of the highly arched diaphragm is in contact with the chest wall as far up as the sixth rib. During inspiration the diaphragm flattens, recedes from the chest wall and permits the lower borders of the expanding lungs to interpose between it and the chest wall; the lungs thus enter the complemental pleura and fill out the corresponding intercostal spaces. The extent of movement of the shadow is, therefore, a measure of the excursion of the diaphragm. In this

respect Litten's method is also a fairly good substitute for the fluoroscope. A normal excursion and a proper respiratory action of the thorax constitutes good evidence of a satisfactory pulmonary capacity. A diminished excursion is present in the early stage of pulmonary tuberculosis, or may occur in conditions of great prostration from any cause. Absent excursion is seen in pleural effusions, pneumonia of the lower lobes and in emphysema, as the diaphragm in such cases is held away from contact with the chest wall. It may be due to pleuritic adhesions between the chest wall and the diaphragm, whereby the descent of the latter is prevented. A contracted (fibroid) or adherent lung may be unable to descend into the complementary space. A very large ascites also may abolish the phenomenon, although abdominal tumors, either solid or fluid, provided they are not of great size, do not hinder the movement of the diaphragm and the production of the shadow. This fact may afford a valuable differential sign in deciding between a right pleural effusion or enlargement of the liver, on the one hand, and a subphrenic abscess on the other. The finding of the Litten's phenomenon speaks for the subphrenic abscess.

By the term "apnea" we mean no breathing. Often in medical literature it is used wrongly to express suffocation. It is due to stimulation of the respiratory centers, and is brought about by rapid and prolonged ventilation of the lungs caused by removal of carbon dioxid from the blood; rhythmical inhibition of the respiratory centers through the vagus endings in the lungs.

When disturbances of external respiration ~~become~~ considerably greater than can be met by compensatory mechanism, asphyxia is produced. The symptoms such as we see, namely, suffocation, convulsions, calm—due to exhaustion of the respiratory centers, long-drawn inspiration, quietness and death are due to lack of oxygen and, secondly, to an increase in the carbonic acid gas.

Muscular work increases the rate and amplitude of respiratory movements, probably due to certain substances produced in the muscles, which are thrown into the blood.

All living things are killed when the oxygen pressure is high—from 300 to 400%. Warm-blooded animals die with convulsions when three atmospheres of pure oxygen or fifteen atmospheres of air is reached. A pressure of two atmospheres of air (40%) shows no injurious effect.

No bad results are seen from a diminished amount of oxygen until 10% is reached. At or below this amount the hemoglobin of the blood cannot take up oxygen. At 10% respiration becomes deeper, more frequent, and the lips become blue. At 8% the face assumes a leaden color but distress is not marked. At 5% marked panting, clouded senses, loss of power is observed, and at 1% to 2% there is loss of consciousness in 40 or 50 seconds. If maintained for some time, death with convulsions occurs when the pressure is diminished to 6%. The effects of an increased amount of carbon dioxid are that hypernia, which is excessive or abnormal mental activity, occurs at a concentration of 3%. A distinct dyspnea is seen at a concentration of 8%, 10%, 15%.

Cheyne-Stokes respiration is seen in arteriosclerosis, uremic states, cerebral edema, fatty degeneration of the heart, kidney diseases, and other conditions. It is always a grave sign in the adult. There is a gradual increase, climax, and a gradual fall in the curve of the respiratory movements, followed by a pause. The ascending and descending phases are about the same in length of time. The average is three cycles per minute. The real cause is not known, although it is seen to occur generally when the nerve centers of respiration are fatigued, or the vitality is lowered. The action tends to be periodic.

Biot's respiration is sometimes called meningeal respiration. This is a very decided pause from several seconds to half a minute, and is more, or less, periodic. This is also a grave prognostic sign.

Dyspnea is an altered form of breathing produced by various conditions which serve to promote the object of breathing. It is increased for the demands upon the oxidation processes and when the respiratory processes are obstructed. Both the deficiency of oxygen and the excess of carbon dioxid are of importance in the cause of this condition. In cyanosis, the difference in color between the arterial and venous blood is due to a changed percentage of oxygen, and the blue color of the peripheral veins is attributed to interference with the light rays in the skin. The primary cause of cyanosis seen in divers returning to the surface is the consumption of the circulating oxygen. The condition of collapse in

peritonitis, and partly so in cholera, is due to the reduction of pressure in the aortic system whereby the organs do not receive a sufficient supply of blood and become impoverished in oxygen. In disturbances of the respiratory apparatus with dyspnea, pronounced cyanosis occurs only when the respiration is not strong enough to arterialize the blood through increased pulmonary action.

Cases of prolonged dyspnea without cyanosis are seen in those affections in which the disturbance of respiration is due to direct or reflex excitation of the central nervous organs of the respiratory system. It is frequently observed in dyspnea with high temperature, in the heavy breathing which precedes coma diabeticum, and in bronchiall asthma. Dypsnea may be caused by: (1) pain, (2) diminished breathing surface, (3) general circulatory disturbances, (4) disturbances of the upper air passages, (5) bronchitis, (6) bronchial asthma, (7) emphysema, (8) uremia of nephritis, (9) fever, (10) anemia.

Asthma is an expiratory dyspnea. It is probable that the dyspnea is due to a spasmodic contraction of the unstriped muscular fibers in the bronchioles. At times there may be a true inflammation of the mucous membrane of much of the respiratory passage. The hindrance to the entrance and exit of air is due to: (1) swelling of the mucous membrane, (2) abnormal secretion of mucus, (3) spasm of the diaphragm induced by stimulation of the vagus, (4) spasm of the muscles of the small bronchi (Krehl). The attacks may be produced reflexly. Stimulation most frequently is made upon the sensitive parts of the respiratory tract, as the turbinates of the nose and the surface of the finer bronchi.

Emphysema is a dyspnea due to diminished expiratory power and decreased aerating surface, consequent to vesicular atrophy and loss of capillaries in the walls. The prolonged expiration is due to diminished elasticity of the lung tissue.

Actual pain may be caused by diseases of the respiratory apparatus. Most authors believe that the lungs themselves contain no fibers that are capable of transmitting sensations of pain, and that all pulmonary pains arise from the pleura or the chest wall. Severe pains are frequently present in dry pleurisies, and since the latter often accompany diseases of the lungs, it is possible that they are responsible for the pain present in many of these cases. Pain, however, may be present in diseases of the lung which are not accompanied by pleurisy.

BIBLIOGRAPHY.

Piersol's Human Anatomy.
Cunningham's Human Anatomy.
Miller, William Snow: Anatomy of the Lung, last edition of the "Reference Handbook of the Medical Sciences."
Fetterolf, George: The Anatomic Explanation of the Greater Amount of Vocal Fremitus and Vocal Resonance Normally Found at the Apex of the Right Lung, Arch. Int. Med., February, 1909, p. 23.
Norris and Landis: Diseases of the Chest and the Principles of Physical Diagnosis.
Reichert, Edward T.: Recent interview.
Krehl's Clinical Pathology.
Rhodes' Applied Physiology.
Howell's Text Book of Physiology.
Butler's Physical Diagnosis.
Goepp's State Board Questions and Answers.
Reckord, Frank F. D.: The Anatomy, Physiology and Pathology of the Blood Vascular System, Pennsylvania Medical Journal, October, 1917, Vol. xxi, p. 41.

A PORTABLE RESPIRATION APPARATUS FOR CLINICAL USE.*

BY FRANCIS G. BENEDICT, BOSTON.

THE value of studies of the gaseous metabolism in clinical and surgical treatment is being increasingly recognized. Metabolism studies are frequently made for such use, but unfortunately the technic is somewhat complicated, particularly as many of the methods employed require gas analysis. Although the cumbersome gas-analysis apparatus of Zuntz-Geppert has been superseded by the more portable form of Haldane, gas analysis in all its intricacies still remains the bugbear of workers in gaseous metabolism. Furthermore, the gas analyst, to retain his skill, must analyze practically every day.

In all forms of respiration apparatus, the technical errors inevitably fall primarily on the determination of the oxygen consumption. Any method of determining the gaseous metabolism in short periods, which does not give accurate measurements of oxygen consumption, can have but limited value for the study of pathological cases; for of the two respiratory gases, carbon dioxide and oxygen, the latter is the better index of the total metabolism and the energy transformations.

It was formerly believed that direct heat measurements were absolutely necessary for accurate estimates of the energy transformations in the body, but Gephart and Du Bois[1] have admirably shown that even during short periods of one hour the heat calculated from the measurement of the gaseous metabolism (indirect calorimetry) compares very closely with that di-

* From the Nutrition Laboratory of the Carnegie Institution of Washington, Boston, Mass.

rectly measured in a respiration calorimeter similar to those used in the Nutrition Laboratory. Thus today we may confidently assert that an accurate measurement of the oxygen consumption is a very close index of total heat production. The calorific value of 1 liter of oxygen, *i.e.*, the heat produced when 1 liter of oxygen is absorbed in the body, remains relatively constant irrespective of whether oxygen is used to burn fat (calorific value per liter of oxygen, 4.686 calories) or to burn carbohydrate (calorific value per liter of oxygen, 5.047 calories). On the other hand, the calorific value of carbon dioxide, that is, the heat accompanying the excretion of 1 gram of carbon dioxide, varies considerably, depending upon whether the carbon dioxide is derived from the combustion of fat (calorific value per liter of carbon dioxide, 6.694 calories) or from the combustion of carbohydrate (calorific value per liter of carbon dioxide, 5.047 calories). Unfortunately, as has already been shown, the oxygen consumption is usually the more difficult factor to determine.

The best type of apparatus to use for measuring the gaseous metabolism of hospital patients has been a matter of special consideration. In measuring the metabolism with any type of respiration apparatus, we have always to consider the fundamental physiological error due to a possible disturbance of normal respiration. As already pointed out,[2] all forms of respiration apparatus in which a mouthpiece or nosepieces are employed (and this does not include the use of a mask permitting free breathing) are subject to criticism on account of the altered type of respiration. This physiological alteration of respiration affects primarily the carbon-dioxide excretion. For instance, a temporary over-ventilation of the lungs produces an excessive sweeping out of carbon dioxide. This results in an abnormally high value for the carbon-dioxide excretion, which of course materially disturbs the respiratory quotient. Such alterations of the respiration are especially liable to occur with hospital patients, who are frequently inclined to be apprehensive and annoyed by the attachment of breathing appliances. It was for this reason that the clinical respiration chamber,[3] which insures normal untrammelled breathing, was devised. A replica of the apparatus has been successfully used at the New England Deaconess Hospital and elsewhere for the determination of the respiratory quotient of patients; we believe it to be the best method for this specific purpose.

The technical skill of Dr. Thorne M. Carpenter of the Nutrition Laboratory has enabled him to use a mask applied to a patient's face, the mask being supplemented by expiratory and inspiratory valves; the expired air is collected in a spirometer and analyzed with the Haldane apparatus. This procedure has been successfully copied in many hospital laboratories. With an expert gas analyst and the daily use of a good gas-analysis apparatus, the method gives very satisfactory results, inasmuch as the application of the mask to the face is undoubtedly a much less disturbing factor in respiration than the insertion of either a mouthpiece or nosepieces.

All of the forms of respiration apparatus heretofore used for pathological study require considerable time for the completion of their several experimental processes. Usually to secure duplicate results it is necessary for the patient to remain in the laboratory at least an hour or an hour and a half, and with most types of apparatus the experiment must be followed by an hour or more of trying gas analysis. Neither the universal respiration apparatus[4] nor the clinical respiration chamber[3] require gas analysis, but with both apparatus a special meter is used for the measurement of the oxygen consumption, with corrections for barometric and temperature changes and frequent calibration. While the clinical respiration chamber especially leaves little to be desired so far as accuracy and simplicity of operation are concerned, the two apparatus are yet sufficiently complicated to demand considerable regular attention to keep them in working condition. Furthermore, they both need not a little space for operation and are not portable, inasmuch as they cannot be readily transported from ward to ward or from the bedside of one patient to that of another in the hospital. *The need of a portable apparatus designed to give, without gas analysis and without meters or weighings, a rapid and accurate measurement of the oxygen consumption, is very great.*

The oxygen consumption is not only the more important of the two respiratory gases, at least so far as its significance in quantitative measurements of the total metabolism is concerned, but it has the further advantage over the carbon-dioxide production of not being affected by abnormal respiration unless the over-ventilation of the lungs is so extraordinarily large as to necessitate excessive muscular exertion. Consequently a type of apparatus which is to be

used primarily for measurements of the oxygen consumption and only secondarily for measurements of the carbon-dioxide production, may, with propriety, employ a mouthpiece. It is with this fact in mind that the portable respiration apparatus here to be described has recently been devised.

DESCRIPTION OF THE APPARATUS.

In the portable respiration apparatus the patient breathes into and out of a confined volume of air that circulates through a series of purifiers which remove the carbon dioxide as fast as formed. As the air passes through the lungs of the patient, oxygen is absorbed from the air, with a consequent gradual decrease in the oxygen content. The decrease in the total volume of the air represents the volume of oxygen consumed.

The portable respiration apparatus consists of a mechanical blower to circulate the air, three bottles containing purifying material to remove the carbon dioxide and water-vapor, and a spirometer with suitable piping and connections. The spirometer serves the triple purpose of providing (1) a suitable housing for the mechanical blower; (2) a fluctuating factor in the air circuit to allow for inspiration and expiration, *i.e.*, an expansion chamber; and (3) a measure of the oxygen consumed by means of a direct reading of the level of the spirometer bell at the beginning and end of an experiment.

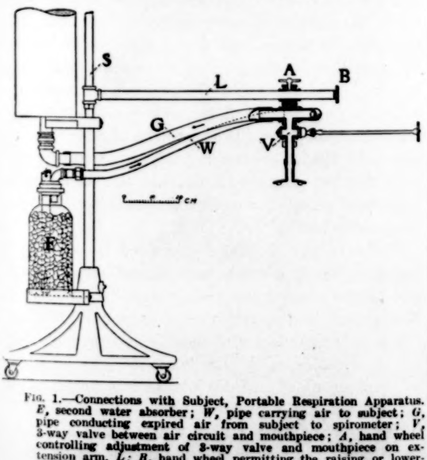

FIG. 1.—Connections with Subject, Portable Respiration Apparatus. *E*, second water absorber; *W*, pipe carrying air to subject; *G*, pipe conducting expired air from subject to spirometer; *V*, 3-way valve between air circuit and mouthpiece; *A*, hand wheel controlling adjustment of 3-way valve and mouthpiece on extension arm, *L*; *B*, hand wheel permitting the raising or lowering of *L* on standard, *S*. The portable nature of the apparatus is indicated by the mounting of base on castors.

After leaving the air-purifying bottles, the air passes through a tube to the patient's mouth. The expired air, containing carbon dioxide, is drawn through a large-caliber tube to the spirometer, from which it is whirled by the blower through the purifying bottles, and thence returned to the patient for rebreathing. The connection with the subject is shown in Figure 1 and the general installation and details of the air-circuit in Figure 2.

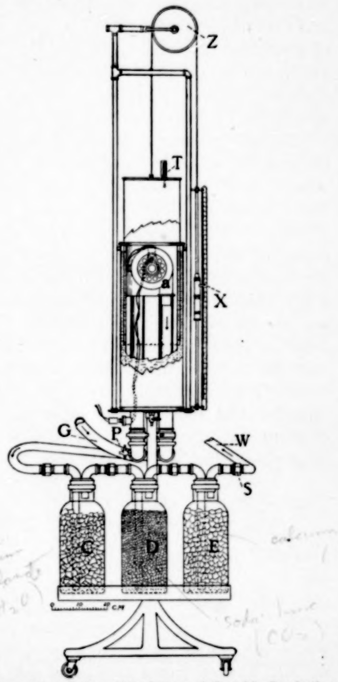

FIG. 2.—Spirometer and Absorbing System of Portable Respiration Apparatus. *G*, large calibre pipe conducting expired air to spirometer; *a*, air-impeller; *C*, first water-absorber; *D*, carbon-dioxide absorber; *E*, second water-absorber; *S*, point at which rate of ventilation may be tested by disconnecting coupling; *W*, pipe conducting purified air to subject; *P*, pet-cock for introduction of oxygen; *T*, thermometer for obtaining records of temperature of spirometer. The spirometer bell is counterpoised by the weight, *X*, attached to silk thread passing over aluminum wheel. *Z*. Scale on which pointer indicates height of spirometer bell is shown at right of *X*.

ROTARY AIR-IMPELLER.

Although this apparatus is a direct development of the universal respiration apparatus,[6] it has many striking similarities to the early "oxygénographe" of Fredericq[7] and the later device of Krogh,[8] and it would be far from our intention to present as "new" the fundamental

features of the clever devices of these investigators. In at least one main particular, however, the new apparatus differs from the earlier forms in that the air is circulated not by the lungs of the patient but by an electrically-driven fan. There are no valves to be actuated by the lungs, and the fan does all the work of circulating the air, passing it through the purifying agents, etc. The lungs are thus relieved of the labor forced upon them by many types of respiratory apparatus, and breathing is as free and untrammelled as is possible with any form of breathing appliance. While the universal respiration apparatus and the clinical respiration chamber require a positive blower for the circulation of the ventilating air current, since considerable pressure is necessary to pass the air through the sulphuric acid used to remove the water vapor, the absorbents employed in the new apparatus (calcium chloride and soda lime) offer no material resistance; accordingly a small rotary air impeller may be successfully utilized. We have selected for this purpose a small hair dryer which moves a considerable volume of air but cannot give positive pressure. This hair dryer is light in weight and provided with a universal motor so that it can be used with either alternating or direct current.* The blower must be oiled at least every other day when in constant use. To avoid possible leaks the blower is placed inside the spirometer.

AIR CIRCUIT.

By reference to Figures 1 and 2, it may be seen that the air leaving the mouth of the subject is pushed along a wide tube, G, enters the spirometer, and is discharged by the air impeller, *a*, into a calcium-chloride bottle, C, where the water vapor from the lungs is removed. It then passes through a soda-lime bottle, D, where the carbon dioxide is absorbed, and next to a second calcium-chloride bottle, E, where the water vapor from the soda lime is absorbed. The air, thus freed from both carbon dioxide and water vapor, is conducted through the tube W to a 3-way valve (V, Figure 1) leading to the lungs of the subject.

Unless the volume of respiration is wholly abnormal, the rate of ventilation produced by the blower is sufficient to deliver enough purified air at the junction of the 3-way valve and the main air pipe to supply all that is needed, *i.e.*, approximately 30 liters per minute. If there is unusually rapid and deep inspiration, so that air is, for a moment, drawn back from the spirometer, the extra wide tube, G, provides a minimum resistance between mouthpiece and spirometer.

TEST FOR RATE OF VENTILATION.

The spirometer, when filled, holds about 7 liters. The rate of ventilation may be approximately determined by opening the system at the coupling, S (Figure 2), and pinching the tube W, thus closing the intake of air. Air from the spirometer is then discharged by the blower at the open coupling, and the time in seconds noted for the spirometer to fall completely (350 millimeters). If 15 seconds is required for the spirometer to fall, the ventilation rate is approximately 28 liters per minute.

ABSORBING SYSTEM.

The calcium-chloride and soda-lime bottles are of simple form and, for convenience, are placed upon a shelf attached to the base of the apparatus. The soda lime is made by the formula of Haldane.[9] It has a distinct yellowish tint which changes to a chalky whiteness as the carbon dioxide is absorbed by the reagent. The efficiency of the reagent and the time for renewal may be judged by the progress of this change in color. When a determination of the oxygen consumption only is desired, as is usually the case, the calcium-chloride bottles may be dispensed with. A greater efficiency of soda lime is thus obtained, for it has been found that the moister the soda lime is, the greater is the absorption of carbon dioxide. Indeed, the expired air may be passed directly through the soda lime if care is taken that the excessive absorption of water does not make the absorbent so pasty as to interfere with the free passage of air. As this is a very important point, the ventilation rate should be frequently tested.

If the reagent becomes exhausted the physiological effect is a somewhat labored respiration due to the unabsorbed carbon dioxide acting as a stimulus to the respiratory center. This is not a serious defect and usually has no quantitative significance in the measurement of the oxygen consumed in the 10 or 12 minute period. At the end of the period the motor must be run a few seconds longer to insure a complete absorption of the carbon dioxide in the air by the soda lime.

* The hair dryer, which is manufactured by the Arnold Electric Co., of Racine, Wisconsin, is purchased without switch, heating unit, or handle, and slightly modified by adding a discharge tube to support the dryer when in position inside the spirometer.

While the labored respiration is evident to the practised eye in a more rapid rate and a larger amplitude of the excursions of the bell, a pneumograph about the chest with attachment for a kymograph record supplies a good picture of the mechanics of respiration and instantly records dyspnea. The excursions of the bell may be directly written on a kymograph by attaching a light pointer to the counterpoise, though the continuous upward trend of the curve as the oxygen is absorbed will permit of but short records.

SPIROMETER.

The spirometer used is a modification of our earlier form of spirometer, the two chief differences being (1) the recessed part which contains the mechanical blower, and (2) the unusual length of the bell. The first provides space for the blower without intricate connections, and absolutely precludes leaks. It is a feature of the apparatus that has proved especially satisfactory in practice. The bell is made of sufficient size to allow not only for a full excursion, if a deep breath is taken, but also for a considerable contraction in total volume of the air in the ventilating circuit as the oxygen is consumed.

To minimize the labor of breathing, the bell is delicately counterpoised by a weight (see X, figure 2) on the end of a silk cord running over a light aluminum pulley, Z, at the top. A pointer attached to the counterpoise shows, on a millimeter scale, the fluctuations in the height of the bell. To indicate accurately the somewhat large temperature changes a light-weight thermometer,* T, is inserted permanently in the top of the bell. To avoid getting water on the blower, and consequent electrical damage, with danger of setting fire to the insulation in the oxygen-rich atmosphere, the water level in the spirometer should be considerably lowered when the apparatus is to be moved on an uneven floor.

ADJUSTMENT TO SUBJECT.

Almost universal adjustment of the mouthpiece is possible by means of the two hand wheels, A and B. (See figure 1.) The former controls the movement of the 3-way valve and mouthpiece around the extension arm, L, as an axis, and also their location on the extension arm, while B permits raising or lowering the arm L on an upright standard, S. The extension arm can also be swung about S within the scope of the two rubber tubes, W and G. With no further adjustment the arm L may be placed in position for a patient either lying in bed or sitting in a chair. When used for experiments with the patient in the standing position, the base is mounted on a wooden box of the desired height.

BREATHING APPLIANCES.

Although, for the sake of simplicity, in this discussion of the portable respiration apparatus, the mouthpiece only is referred to and shown in the diagrams, we have reason to believe that the original form of inflated nosepiece used in the Nutrition Laboratory may be of even greater practical value, inasmuch as it has less influence upon the type of respiration. (See Figure 3.) For these nosepieces, a piece of glass tubing is used with a rubber finger cot attached to one end and a 1-hole rubber stopper at the other. A small hole in the finger cot permits it to be

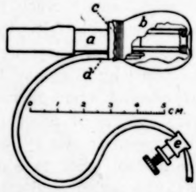

FIG. 3.—Pneumatic Nosepiece. *a*, glass tube to which is fastened rubber finger cot, *b*, which is drawn back over rubber stopper, *c*. A small piece of glass tubing with rubber tubing attached, *d*, serves for dilating the rubber cot, *b*; the clamp *e* closes *d* after *b* is inflated.

turned inside out, drawn back over the rubber stopper, and fastened in place. Provision is made for inflating the finger cot and fitting it to the nostril by the insertion in the rubber stopper of a piece of small-bore glass tubing with a short length of rubber tubing attached. After the nosepieces are inserted in the nostrils of the subject, the finger cots are inflated by means of a hand bulb. The nosepieces should be tested before an experiment with pressure under water.*

Although at first sight the use of a mask in a closed circuit apparatus of this type would seem impracticable, as the slightest leak between the mask and the face would have a pronounced effect upon the measurement of the oxygen, actual experience with the mask in the Nutrition Laboratory has given good results, and it is be-

* At present a small Fahrenheit thermometer is used, as a Centigrade instrument of like weight and temperature range is not available.

* For a full description of these nosepieces, also method of use, see Carpenter, Carnegie Inst. Wash. Pub. No. 216, 1915, pp. 22, 23.

lieved that a little patience in experimenting will make it perfectly possible to use the mask with the new apparatus. This form of breathing appliance is much more comfortable for patients, permitting, as it does, free nose and mouth breathing, without the objectionable features of the mouthpiece, which produces a definitely abnormal respiratory rhythm.

AIR-MOISTENER.

Since with any type of breathing appliance the purified air passing along the tube is too dry to be breathed comfortably by the subject, a small moistening device, consisting of a wire gauze frame covered with linen and thoroughly drenched with water, is inserted in the connection between the mouthpiece, or other breathing appliance used, and the circulating air.*

OXYGEN SUPPLY.

If the whole apparatus is filled with air at the beginning of a period, the percentage of oxygen in the confined air being breathed will fall considerably and might easily reach the point at which oxygen-want would be felt. Consequently, since the spirometer is of generous size and it has been established by Higgins[10] that the respiration of oxygen-rich atmospheres is without effect upon the gaseous metabolism, a liberal supply of pure oxygen from a cylinder is introduced into the system prior to connecting the mouthpiece with the patient and after an equivalent volume of air has been expelled through the 3-way valve. During the experiment the volume of air in the spirometer is decreased by approximately 250 c.c. per minute, or 2½ liters in a 10-minute period. A rough calculation will indicate the probable amount of pure oxygen to introduce. In the course of an experiment there is an exchange of oxygen for nitrogen in the lungs and blood, so that the air in the system contains a little more nitrogen than at first, but repeated tests have shown that the percentage of oxygen in the residual air at the end of a 10-minute, or even 15-minute, experiment is always very considerably above that of the oxygen in outdoor air. Consequently, patients can never suffer from oxygen-want.

EXPERIMENTAL PROCEDURE.

The use of the apparatus should be preceded each day by a test for tightness, which is easily made by placing a 100-gram weight on top of the spirometer. If there is a leak at any point the spirometer will show it definitely in three minutes. After the weight is removed, the motor is started and approximately 2½ liters of pure oxygen admitted from the cylinder through the pet-cock, P (Figure 2). As each millimeter on the scale corresponds to approximately 21 c.c. (the exact value is determined at the time of construction),† this amount of oxygen is sufficient to raise the bell approximately 120 millimeters. The oxygen is best introduced when the spirometer bell is about one-third of the distance above its lowest level, as this allows for exaggerated expiration or inspiration without completely filling or emptying the spirometer.

Since the apparatus is primarily designed for measuring oxygen only, for the time being we need not consider the method of measuring the carbon dioxide. The connection of the subject with the air circuit is controlled by the 3-way valve (see V, Figure 1) which may be opened directly to the room air or, by turning it 90 degrees, connected with the ventilating air circuit. A small double-headed arrow, stamped on the top of the valve, indicates in which direction it should be turned. The opening to the room air usually points down and is not shown in Figure 1. A short elbow is attached to this opening and over the end of the elbow a small piece of goose down is fastened with a bit of wax. The movements of this feather indicate the respiration rate and the end of each expiration.

With the breathing appliance attached, the patient is first allowed to breathe room air through the side opening of the 3-way valve. The temperature of the spirometer bell and the position of the pointer on the scale are recorded, also the barometer,‡ which should be read to the nearest millimeter. As soon as the respiration appears normal, the 3-way valve is quickly turned 90 degrees to connect the subject with the air current. This should be done at the end of a normal (not forced) expiration. At the moment of turning the valve, the exact time is noted, preferably with a stop-watch. Practically no further attention need be given to the subject or apparatus until the end of the experiment. It is preferable to have the subject keep awake during the experimental period, and we frequently

* All workers in gaseous metabolism should refer to the monograph by T. M. Carpenter (Carnegie Inst. Wash. Pub. No. 216, 1915) for detailed description of respiratory apparatus of practically all the current types, with special reference on pp. 23, 36 and 37 to mouthpiece, nosepieces, and moistening device.

† Seven bells made on the same form gave by actual calibration the following values per millimeter: 20.99, 20.97, 20.86, 20.86, 20.83, 20.97, and 20.97 c.c., with an average of 20.92 c.c.

‡ A good aneroid barometer reading in millimeters is satisfactory, as an error of 7 or 8 millimeters introduces an error of but 1 per cent. in the final calculations.

find it necessary to tap on the air-pipe to make sure that he has not fallen asleep. At the end of 10 or 12 minutes, the excursions of the bell are carefully watched and at the conclusion of a normal expiration the 3-way valve is again turned, disconnecting the subject from the ventilating air current; the time is then noted. The mouthpiece and nose clips are removed, and the subject lies quietly until another period is begun.

It is a fundamental rule in this Laboratory that all subjects, prior to measurements of the gaseous metabolism, must be lying down, resting quietly for not less than 30 minutes. The length of time between periods need be determined only by the activity of the operator in recording his observations. After the end of the period one minute is allowed to elapse to insure a thorough mixing of the air and removal of carbon dioxide. When the pointer indicates that the level of the spirometer is constant, this is read and the temperature is recorded.

MODIFIED METHOD FOR DETERMINING THE OXYGEN CONSUMPTION.

In testing several of these apparatus, Mr. Louis E. Emmes, of the Laboratory staff, has had excellent success in determining the oxygen consumption by using a modification of the method outlined in that he reads the spirometer *after* the subject has been connected with the air current. Noting the height to which the spirometer is raised at the end of a series of regular normal expirations, he starts a stop-watch. The experimental period then continues about 12 minutes, when again the height of the spirometer at the end of a series of three or four normal expirations is noted and recorded, and simultaneously the watch is stopped. Using the difference between the two readings as an index of the oxygen consumption, the usual calculations for temperature and pressure are then applied.

The obvious advantage of the Emmes method lies in the fact that while the goose feather over the opening in the 3-way valve gives a fair indication of the end of a normal expiration for determining the moment to begin the experimental period, this point is much better indicated by the actual excursions of the spirometer bell. Mr. Emmes thus uses the excursions of the bell to begin, as well as to end, the period. The two methods may be simultaneously applied and one period be made to include another. This involves only two additional readings of the height of the spirometer bell and two additional time records with a second stop-watch. The use of the modified method is recommended in all cases as a desirable check. A series of tests shows that a somewhat better agreement of duplicate periods may be obtained with the Emmes method.

A still further check may be obtained by making the usual records before and after the valves are turned at the beginning and end of the period, and employing the Emmes method for two additional readings, 10 or 20 seconds apart, at the beginning of the period after the subject has been connected with the air current and again before he is disconnected at the end of the period. Two stop-watches are used for these intermediate records. Thus two sets of readings are secured for control within one 12 to 13-minute period, and in one 15-minute period it is possible to secure readings for three determinations of the oxygen consumption.

At the conclusion of a period, oxygen is again admitted, the initial position of the spirometer read, connections made with the subject as before, and a new period begun. All of this can be carried out without stopping the motor. If, during the first period, a larger amount of oxygen has been introduced than is actually consumed, a little more air can be rejected by turning the 3-way valve and lifting slightly the counterpoise. It is thus seen that the oxygen consumption may be approximately measured by the fall of the spirometer, and the actual computation of this contraction in volume be completed by using the data obtained regarding the temperature and barometric pressure.

DETERMINATION OF CARBON-DIOXIDE EXCRETION.

Although the portable respiration apparatus was designed primarily for studying the oxygen consumption, and the Nutrition Laboratory is uncertain as to the use of mouth-breathing appliances for measurement of the carbon-dioxide excretion of subjects, it is perfectly feasible to get an approximate measure of the carbon-dioxide excretion and an indication of the probable respiratory quotient with the new apparatus. As the increase in weight of the soda-lime bottle, D, is due to the absorption of carbon dioxide, and that of the calcium-chloride bottle, E, to the absorption of water added to the air in its passage through the soda lime, it is necessary only to obtain an accurate weight of the soda-lime bottle and the following calcium-chloride bottle at the beginning and end of the period. If the

ventilating current of air entering the soda-lime bottle is dried over calcium chloride to a certain tension of aqueous vapor and air leaves the second calcium-chloride bottle at the same tension, it is obvious that no moisture has been added to or taken away from the system comprising the soda-lime bottle and the following calcium-chloride bottle. Hence the increment in weight of these two bottles, taken as a unit, will indicate the weight of carbon dioxide absorbed from the air as it passes through the bottles. Using the 10 to 15-minute period, such measurement gives a high degree of accuracy. The balances used for these weighings are, however, very difficult to obtain at present, as they are manufactured in Germany. The nearest approach to this balance in accuracy that we have yet found is the Torsion balance.*

As has been pointed out in an earlier communication,[11] there is frequently a considerable difference between carbon-dioxide excretion and carbon-dioxide production. The measurements

TABLE I. CALCULATION OF OXYGEN CONSUMPTION IN EXPERIMENT WITH THE PORTABLE RESPIRATION APPARATUS.

Apparatus used: Portable respiration apparatus No. 7.
Breathing appliance: Mouthpiece.
Date of experiment: March 6, 1918.
No. of period: 3, 3*a*, 3*b*.

Subject: E. L. F.
Date of birth: November 27, 1892.
Body weight (nude): 74.57 kilograms.
Height: 172.2 cm.

Period 3 began .... 9.46 A.M.
Period 3 ended .... 10.02 A.M.

Duration period 3 .... 15′ 47″ (15.78′)
Duration period 3*a* .... 11′ 9″ (11.15′)
Duration period 3*b* .... 11′ 26″ (11.43′)

Height of Spirometer Bell	Period 3	Period 3*a*	Period 3*b*
Beginning	396 mm.	380 mm.	374 mm.
End	193 mm.	231 mm.	221 mm.
Difference	203 mm.	149 mm.	153 mm.

Temperature of Spirometer	Period 3	Period 3*a*	Period 3*b*
Beginning	84	87	88
End	100	98	99
Av. (°F.)	92.0	92.5	93.5
Av. (°C.)	33.3	33.6	34.2

Barometer, 750.80 mm.

	Logarithms Period 3	Period 3*a*	Period 3*b*
Difference in height of spirometer bell	2.30750	2.17319	2.18469
Volume per mm. of height of spirometer bell (20.92 c.c.)	1.32056	1.32056	1.32056
Temperature of spirometer reduced to 0° C.*	9.94992—10	9.94950—10	9.94865—10
Pressure reduced to 760 mm.*	9.99471—10	9.99471—10	9.99471—10
Corrected volume of air lost in period, *i.e.*, oxygen consumed	3.57269	3.43796	3.44861
Duration of period	1.19811	1.04727	1.05805
Oxygen consumed per minute	2.37458	2.39069	2.39056
OR	237 c.c.	246 c.c.	246 c.c.
Correction for reduction of total vol. of air to 0° C. and 760 mm. (+1 c.c. for each rise of 1° F.)	+16	+11	+11
Corrected volume of oxygen consumed per min.	253 c.c.	257 c.c.	257 c.c.

Average of three measurements .... 256 c.c. of oxygen consumed per min.

* For formulae, see Benedict and Tompkins, BOSTON MEDICAL AND SURGICAL JOURNAL, 1916, Vol. clxxiv, p. 943.

combined weight of the two absorbers and the total length of the experimental period, *i.e.*, the period of time in which the subject is connected with the air-circuit, we may readily calculate the volume of carbon dioxide excreted per minute.

The accuracy of the measurement of the carbon-dioxide excretion thus depends largely upon the sensitiveness of the balances used. In the Nutrition Laboratory it is possible for us to weigh the bottles to 0.01 gram; as only about 3 or 4 grams of carbon dioxide are produced in a

of carbon dioxide made with an apparatus of this type can therefore, for physiological reasons, *i.e.*, abnormal respiratory types as a result of breathing through a mouthpiece, be considered only as approximate. They have, however, a distinct usefulness in indicating the probable trend of the respiratory quotient and with trained subjects give a close approximation to the true respiratory quotient.

* This balance is manufactured by the Torsion Balance Company, 92 Reade Street, New York, N. Y. Their No. 2000 is listed as capable of weighing 4½ kilograms. Sensitivity, 0.15 gram.

METHOD OF CALCULATING OXYGEN CONSUMPTION.

The method of calculating the amount of oxygen consumed in one period of an actual experiment may be illustrated by period 3 of the experiment with E. L. F. on March 6, 1918. (See Table 1.) In the two earlier periods of this experiment, the mask was employed; in this period the mouthpiece was used, and three sets of records were made. The two intermediate measurements are designated for convenience, "period 3-a" and "period 3-b."

The apparatus and breathing appliance used, the date, and the number of the experimental period are first recorded, also the initials, date, of birth, nude body-weight, and height of the subject. The times of beginning and ending the period are likewise recorded, that is, the exact moment the valve is turned connecting or disconnecting the subject with the air-current. The duration of the three measurements of oxygen are given, the figures in parentheses showing these times with the seconds reduced to decimals for convenience in calculating.

In the middle section records are made of the height of the spirometer bell, also the temperature of the spirometer (°F.) at the beginning and end of the complete period and the intermediate periods. From these records the average temperature (Centigrade) of the spirometer and change in height of the spirometer bell are calculated for the three measurements.

In the lower section the cubic centimeters of oxygen per minute are computed by logarithms. The decrease in the volume of air is first calculated from the difference in height of the spirometer bell by means of the factor for this spirometer (20.92 c.c. for each millimeter of change), then reduced to 0° C. and 760 mm. pressure, using the average temperature of the spirometer during the measurements and the barometer record obtained for the period. Thus the logarithm of the spirometer difference for the total period (203 millimeters) is 2.30750; the number of cubic centimeters represented by each millimeter of difference for this spirometer is 20.92, with a logarithm of 1.32056. The logarithms for the average temperature of the spirometer reduced to 0° C. (9.94992-10) and for the observed pressure reduced to 760 mm. (9.99471-10) are also found from tables prepared for the purpose. The total of the four logarithms gives the logarithm (3.57269) for the loss in volume of the air in the apparatus during the period, which is equivalent to the volume of oxygen consumed. No correction is made in this calculation for the tension of aqueous vapor, as it is assumed that the air as measured is dry.* From the logarithm of this volume is subtracted the logarithm 1.19811 for the duration of the measurement (15′ 47″), the result giving the logarithm for the cubic centimeters of oxygen consumed per minute—in this case 237 c.c.

A further correction in the results obtained by this method of calculating is necessary, inasmuch as the total volume of air in the spirometer and air system should be reduced to 0° C. and 760 mm. pressure at the beginning and end of the measurement to obtain the true shrinkage in the volume of air. Such computations have been made for 14 experiments in which from 198 to 272 c.c. of oxygen were used and with temperature fluctuations ranging from 3° to 19° F. It was found that the difference as a result of making this reduction corresponds to + 1 c.c. of oxygen for each degree Fahrenheit of the rise in temperature during the measurement. It is therefore justifiable, for the sake of simplicity, to make an arbitrary correction by adding 1 c.c. of oxygen for each degree of the rise in temperature of 16° F. This gives a value of 253 c.c. of oxygen per minute consumed during the period of 15 minutes and 47 seconds.

The same method is followed in calculating the oxygen consumed during the other two measurements. The agreement for the two intermediate measurements is absolute, that is, 257 c.c. per minute, while the measurement for the whole period of 253 c.c. per minute is not far from the values obtained in periods 3-a and 3-b.

METHOD OF CALCULATING CARBON-DIOXIDE EXCRETION.

The method of calculating the total carbon dioxide excreted during this period is illustrated in Table II. The weights of the soda-lime bottle (D) and the second calcium-chloride bottle (E) are given for the beginning and end of the period and the differences for the two absorbers added to find the total amount of carbon dioxide excreted. The weights are first converted to cubic centimeters by using the logarithm (2.70680)

* For the measurement of the total period, this assumption is correct. During the measurements in the two intermediate periods (*a* and *b*) made by the Emmes method, there is unquestionably a certain amount of moisture in the air. Theoretically, corrections should be made for this moisture. It has been shown, however, by means of a sensitive psychrometer placed in the air-circuit, that the percentage of moisture is so small that in practice it may be neglected in the calculation of the oxygen consumption during these short periods.

for the factor 509.1, and the cubic centimeters per minute found by dividing by the number of minutes in the period, *i.e.,* 15.78 minutes, with a logarithm of 1.19811. By using the average oxygen consumption per minute, as found in the three measurements, the respiratory quotient is readily calculated. We have therefore, in this period, an average oxygen consumption of 256 c.c. per minute, a carbon-dioxide excretion of 220 c.c. per minute, and a respiratory quotient of 0.858.

TABLE II.—CALCULATION OF CARBON-DIOXIDE EXCRETION AND RESPIRATORY QUOTIENT IN EXPERIMENT WITH THE PORTABLE RESPIRATION APPARATUS.

	Beginning gms.	End gms.	Difference gms.
Weight of carbon-dioxide absorber (D) ..	4,024.84	4,031.19	+6.35
Weight of second water-absorber (E)	3,175.99	3,176.45	+0.46
Total difference in weight, representing excretion of carbon-dioxide during period 3			+6.81

	Logarithms
Total grams of carbon-dioxide excreted ..	0.83315
Factor for converting grams to c.c. (509.1)	2.70680
Total c.c. of carbon-dioxide excreted	3.53995
Duration of period (15.78′)	1.19811
Carbon-dioxide excreted per minute	2.34184=220 c.c.
Oxygen consumed per minute (256 c.c.) ..	2.40824
Respiratory quotient	9.93360—10=0.858

METHOD OF CALCULATING HEAT OUTPUT.

By means of indirect calorimetry it is possible to compute the calories of energy by using the measurements of the oxygen consumption. Zuntz[12] has computed that each liter of oxygen consumed corresponds to a definite heat output, there being no great difference in this relationship, whether the oxygen is consumed in burning carbohydrate (5.047 calories per liter) or fat (4.686 calories per liter). For practically all purposes, especially for clinical work, one may assume that the average respiratory quotient is 0.82.* The calorific value of oxygen at this respiratory quotient is 4.825 calories per liter and 3.377 calories per gram. Consequently, it is necessary only to multiply the liters of oxygen measured by 4.825 to compute the heat output.

SUMMARY OF RESULTS OBTAINED IN ILLUSTRATIVE EXPERIMENT.

A summary of the measurements obtained in the six periods of the experiment with E. L. F. on March 6, 1918, is given in Table III, which shows the carbon-dioxide excretion, oxygen con-

* Average respiratory quotient for 88 men and 66 women. Benedict, Emmes, Roth and Smith, Jour. Biol. Chem., 1914, 18, p. 139.

TABLE III. METABOLISM MEASUREMENTS OF SUBJECT E. L. F., MARCH 6, 1918.

(Values per Minute.)

Date of birth, Nov. 27, 1892; body-weight (nude), 74.57 kilograms; height, 172.2 cms.; subject in post-absorptive condition.

Apparatus and Period	Breathing Appliance	Carbon Dioxide	Oxygen: Individual Measurements	Oxygen: Av. for Period	Heat	Respiratory Quotient	Av. Pulse Rate
		c.c.	c.c.	c.c.	cals.		
Portable Respiration Apparatus							
1.	Mask	203	248 247 239	245	1.19	0.83	68
2.	Mask	207	268 265 262	265	1.27	0.78	65
3.	Mouthpiece	220	253 257 257	256	1.25	0.86	65
4.	Mouthpiece	210	260 270 262	264	1.26	0.79	61
5.	Mask	206	259 256 252	256	1.23	0.81	61
6.	Mask	208	260 255 257	257	1.24	0.81	62
Average		209	257	257	1.24	0.81	64
Clinical Respiration Chamber							
1.	.....	205		241	1.17	0.85	65
2.	.....	207		249	1.20	0.83	65
Average		206		245	1.19	0.84	65

sumption, respiratory quotient, heat output, and average pulse rate for the six periods. The heat was calculated by using the individual quotients. In this experiment the mask was used in the first, second, fifth, and sixth periods, and the mouthpiece in the third and fourth periods. The average carbon-dioxide excretion with the mask was 206 c.c.; with the mouthpiece it was 215 c.c. The average oxygen consumption with the mask was 256 c.c., while that in the two periods with the mouthpiece was 260 c.c. It is thus seen that the results obtained with these two breathing appliances are strictly comparable. The values obtained in two periods of an experiment made on the same day with the same subject, but with the clinical respiration chamber are included in Table III for comparison and show an average value of 206 c.c. for the carbon-dioxide excretion, 245 c.c. for the oxygen consumption and 1.19 calories for the calories of energy. It is of significance that these measurements, made under conditions of somewhat reduced muscular tonus, approximate those found with the portable respiration apparatus.

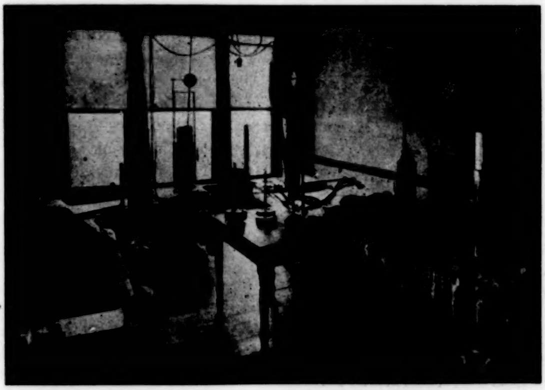

FIG. 4.—Portable respiration apparatus ready for bedside use with four subjects at the International Young Men's Christian Association College, Springfield, Massachusetts.

PRACTICAL USE OF THE APPARATUS.

While the apparatus was primarily designed for clinical purposes, particularly for hospital use, the Nutrition Laboratory recently found itself confronted with the task of measuring simultaneously the basal metabolism of a group of young men between 5 and 6.30 o'clock every morning. Seven of these apparatus were constructed and were in continuous use at the International Y. M. C. A. College, Springfield, Mass., between September, 1917, and February, 1918. Every morning two 10-minute periods were obtained with each of seven subjects. One of the laboratory rooms is shown in Figure 4 with four of the apparatus and the accompanying beds. Subsequent tests have demonstrated that the portable respiration apparatus meets all the exacting requirements of the Nutrition Laboratory as an instrument for clinical work.*

From the foregoing description it will be seen that this apparatus dispenses with gas analysis and for the most part with weighings of any kind. By reading the millimeter scale indicating the height of the spirometer bell, the thermometer in the top of the spirometer, and the barometer, we may obtain all the data required for rapidly computing the oxygen consumption and the heat production. As the apparatus is more especially designed for clinical work, it cannot be substituted in exact studies of the metabolism for the method outlined by Dr. Carpenter, namely, a closely fitting mask, Tissot valves, a carefully calibrated spirometer, a good gas-analysis apparatus, and, most important of all, a good gas analyst.[13] Neither can it give the results obtained with the universal respiration apparatus and the perfected form of the clinical respiration chamber. It has, however, the advantages of portability, simplicity, and rapidity of opera-

* One of these apparatus has already been supplied to the Battle Creek Sanitarium for the use of Dr. Paul Roth.

tion, with a sufficient degree of accuracy to meet the needs of practically all clinical work.

REFERENCES.

[1] Gephart and DuBois: Arch. Int. Med., 1915, 15, p. 850.
[2] Benedict and Tompkins: BOSTON MEDICAL AND SURGICAL JOURNAL, 1916, 174, p. 864.
[3] Benedict and Tompkins: BOSTON MEDICAL AND SURGICAL JOURNAL, 1916, 174, pp. 857, 898, 939.
[4] Benedict: Deutsch. Arch. f. klin. Med., 1912, 107, p. 156.
[5] Benedict and Tompkins: BOSTON MEDICAL AND SURGICAL JOURNAL, 1916, 174, pp. 857, 898, and 939.
[6] Benedict: Deutsch. Arch. f. klin. Med., 1912, 107, p. 156; see also Am. Jour. Physiol., 1909, 24, p. 345.
[7] Fredericq: Arch. de Biol., 1882, 3, p. 687; also Éléments de Physiologie Humaine, Gand and Paris, 1888, 2nd ed., p. 141.
[8] Krogh: Skand. Arch. f. Physiol., 1913, 30, p. 379.
[9] Haldane: Jour. Physiol., 1892, 13, p. 422. The prepared soda lime may be purchased from Stanley Jordan & Co., 93 Water Street, New York City.
[10] Benedict and Higgins: Am. Jour. Physiol., 1911, 28, p. 1.
[11] Benedict and Tompkins: BOSTON MEDICAL AND SURGICAL JOURNAL, 1916, 174, p. 863.
[12] Zuntz and Schumburg: Physiologie des Marsches, Berlin, 1901, pp. 260 and 361.
[13] Benedict and Carpenter: Carnegie Inst. Wash. Pub. No. 261, 1918, p. 353. In press.

Book Reviews.

Neurosyphilis. Modern Systematic Diagnosis and Treatment. By E. E. SOUTHARD, M.D., Sc.D., and H. C. SOLOMON, M.D. Boston: W. M. LEONARD. 1917.

This book is Monograph No. 2 of the Psychopathic Hospital of Boston, and is a most welcome contribution to our knowledge of this condition. The plan of the book, that of the "case method," gives a most excellent idea of the bewildering variety of clinical pictures which may be produced by the various forms in which syphilis may attack the nervous structures. The abundant material at the Psychopathic Hospital has given a large number of cases with which the authors have been able to illustrate the clinical varieties of neurosyphilis. One must admit that the case history method of presentation of any subject in medicine has its limitations, and these natural limitations are, in our opinion, more serious when one is treating of this subject of neurosyphilis than in the handling of many other subjects. However this may be, the illuminating comments and questions following the notes of each case do much to throw light upon, and to suggest new points of view in regard to the many problems which come up in connection with this class of cases.

It is particularly to be commended that the writers, throughout the book, keep so constantly before the reader the pathologico-anatomical differences in the cases according to whether the structures affected are vascular, meningeal or parenchymatous. On reading this book, however, one cannot help wishing that the authors, from their abundant material and experience had devoted more space to a fuller and more systematic discussion of the many problems of neurosyphilis, especially to the one for which they seem so well fitted,—the relation of symptoms to pathological changes.

One or two other points deserve further mention. Too much stress and importance, throughout the book, are laid upon the various laboratory tests, both of the blood and of the spinal fluid, and that both in regard to diagnosis, and as a guide to treatment. All physicians recognize these tests as of the greatest help. But at the present time a word of caution in regard to placing implicit trust in them is not out of place in any authoritative book. The view of most neurologists and internists of large clinical experience is that usually too much reliance is placed upon these tests rather than too little, as one might suppose from remarks here and there throughout the book. No hint is given of such things, not uncommon in experience, as the finding of positive Wassermann or gold chloride tests in cases of glioma of the brain or other non-syphilitic diseases of the nervous system. Again one could wish for more systematic and fuller discussion of the great question of the treatment of these forms of disease. The effect of treatment in cases of paresis is given in much too rosy hues. So far as is known to the reviewer, literature on this subject fails to reveal a single undoubted cure of this disease by any method, though some of the more recent methods in particular seem to warrant some small hope of cure, if applied vigorously in early cases. We must admit that the present pessimism of most neurologists in this matter, to which the authors themselves refer, is justified fully by our present knowledge.

Two minor points may be mentioned, in addition, which might be remedied. Such a misstatement as that in page 430, that the modification of the law in regard to commitments of the insane has given to hospitals a "great group of cases formerly not at all accessible to hospital diagnosis and treatment," should certainly be modified in future editions of this book. It also is a pity to see such an excellent book marred by the constant repetition of such a barbarism as the use of "insult" in the German sense of the word.

THE BOSTON

Medical and Surgical Journal

Established in 1828

An independently owned Journal of Medicine and Surgery published weekly under the direction of the Editors and an Advisory Committee, by the BOSTON MEDICAL AND SURGICAL JOURNAL SOCIETY, INC.

THURSDAY, MAY 16, 1918.

EDITORS

ROBERT M. GREEN, M.D., *Editor-in-Chief*
GEORGE G. SMITH, M.D., *Assistant Editor*
WALTER L. BURRAGE, M.D. *For the Massachusetts Medical Society*

COMMITTEE OF CONSULTING EDITORS

WALTER B. CANNON, M.D.
HARVEY CUSHING, M.D.
DAVID L. EDSALL, M.D.
REID HUNT, M.D.
ROGER I. LEE, M.D.
ALLAN J. MCLAUGHLIN, M.D.
ROBERT B. OSGOOD, M.D.
MILTON J. ROSENAU, M.D.
EDWARD C. STREETER, M.D.

ADVISORY COMMITTEE

EDWARD C. STREETER, M.D., Boston, *Chairman*
WALTER P. BOWERS, M.D., Clinton
HOMER GAGE, M.D., Worcester
JOEL E. GOLDTHWAIT, M.D., Boston
LYMAN A. JONES, M.D., Swampscott
ROBERT B. OSGOOD, M.D., Boston
HUGH WILLIAMS, M.D., Boston
ALFRED WORCESTER, M.D., Waltham

SUBSCRIPTION TERMS: $5.00 *per year, in advance, postage paid for the United States.* $6.56 *per year for all foreign countries belonging to the Postal Union.*

An editor will be in the editorial office daily, except Sunday, from twelve to one p.m.

Papers for publication, and all other communications for the Editorial Department, should be addressed to the Editor, 126 Massachusetts Ave., Boston. Notices and other material for the editorial pages must be received not later than noon on the Saturday preceding the date of publication. Orders for reprints must be returned in writing to the printer with the galley proof of papers. The Journal will furnish one hundred reprints free to the author, upon his written request.

The Journal does not hold itself responsible for any opinions or sentiments advanced by any contributor in any article published in its columns.

All letters containing business communications, or referring to the publication, subscription, or advertising department of the Journal, should be addressed to

ERNEST GREGORY, *Manager*,
126 Massachusetts Ave., Corner Boylston St., Boston, Massachusetts.

THE PRESENT STATUS OF VENEREAL PROPHYLACTICS.

THE modern tendency to hygiene is seen in nothing more plainly than in the public discussion of venereal diseases and their prevention, which are no longer considered forbidden topics by educated persons. In some reviews and newspapers measures of personal prophylaxis for those who are about to expose themselves, or who have exposed themselves, to possible infection, are enjoined in the case of members of the naval and military forces. These prophylactic measures are spoken of, both in the medical and lay press, as highly efficient. The result is that the public has been led to believe in their practical safety and certainty. This is decidedly unfortunate in view of the fact that there is no germicide or method of medical prevention which can be regarded as absolutely prophylactic.

Many authorities take the view that calomel cream and germicidal solutions would stamp out venereal diseases, especially gonorrhea, but they state that, in advocating them before exposure, medical men and officials overstep the limit of what is permissible in prophylaxis. Other authorities—and these are the most recent—state that the use of prophylactic outfits stimulates vice and provokes disease, and that if a stage of great improvement is reached by the public it will be due to moral causes. This is a question of crucial importance.

In order to obtain the most enlightened and detached educational opinion, we submitted the matter to Dr. Charles W. Eliot, of Harvard University. We found that his views are in thorough harmony with the growing feeling of the educated, and particularly the medical public, that further efforts are urgently needed to prevent the spread of venereal diseases. He said:

"It is a question of effectiveness in checking this scourge. What is the most effective thing to do? There are two chief methods,—public clinics and prophylactics,—that is, after exposure. The issue of prophylactic packets, as a matter of course, I think a harmful suggestion. To issue a prophylactic packet to every soldier or sailor who is having a leave of absence is to make an inexpedient suggestion to the young men. But I regret to say I have encountered a good many physicians who do not seem to think that suggestion inexpedient. It is an urgent practical question whether an agreement can now be reached among medical men, army surgeons, and the ordinary laymen who think on these subjects. This seems to be the precise point to work at. I am very much in favor of attending to the next thing to be done, rather than to some far-off object. It is a matter of practical effort. I believe that, as a protective or defensive measure, the public is ready for the venereal clinic or dispensary."

This opinion coincides in most respects with that enunciated at the latest meeting of the National Council for Combating Venereal Diseases. This body, after the examination of many witnesses and much careful consideration, has come to definite conclusions, which are wholly in favor of moral, social, and legal measures, that is to say, of accurate and enlightened information, venereal clinics, and the punishment of persons who deliberately infect others.

An attempt has also been made to obtain precise statistical information of the value of prophylactics, that is, calomel, bichloride of mercury and germicidal injections, but for

fairly obvious reasons the information obtainable is incomplete. The best statistics are based upon a comparison between 100 cases in which these prophylactics are used and of 100 cases in which they are not. Even this method does not cover all the details of the matter. These are most explicitly described in a statement by Mr. E. B. Turner, F.R.C.S., published in the *British Medical Journal* of February 16, 1918: "With regard to the whole question at issue of prophylactic outfits, my personal opinion is that it might not be much real use in diminishing the actual number of cases of venereal diseases occurring in the army. In the first place, no one can say that the methods afford absolutely certain and sure protection from the infection either of gonorrhea or syphilis." As a matter of experience, he finds that they do not, and he points out that even the best methods may fail, because they require for their application a cool head and deft hands. Again: "If a man incurs the risk of infection three or four times in a few hours, it is very improbable that before each performance he is likely again satisfactorily to protect himself." There are other circumstances incidental to sexual indulgence which deprive prophylactics of their effect, or rather, put them out of the question altogether. It is absurd to think that men and women will arm themselves with packets for their love affairs; yet it is in these circumstances that venereal infection is spread. On this particular phase, Mr. Turner writes: "Of 100 men, only 28 had got the infection from professional prostitutes." From this he infers that prophylactics have only a limited application, while there are no limits to venereal diseases, and not even a peace of exhaustion ever comes to them.

The Army and Navy statistics relate only to a limited, though most important, body of men. They show a large admission rate, especially for gonorrhea, since prophylactics were introduced. Syphilis appears to be less affected, the admission rate for this disease remaining much the same. But the position of syphilis is altogether different from that of gonorrhea. It has been found that 17% of recruits for the United States Navy are infected with syphilis, and 18.9% of British recruits. According to Dr. Richard C. Holcomb, U.S.N., the admission rate for gonorrhea, before the introduction of prophylaxis, was 47.23 per 1000, but that it has been raised to 91.91 per 1000 since the "propaganda" began (*Military Surgeon,* 1916, Vol. 38).

Prison statistics are more precise, that is, statistics as to venereal diseases among prisoners, warders, guards, and soldiers who garrison civil and military prisons. These figures show that a very large proportion of the population is infected with syphilis, and that the spread of all venereal diseases is too insidious to be dealt with easily. Professor Charles Ruata of the University of Pavia, writes that it is best to put into the hands of soldiers the simplest means which will enable them to protect themselves. Of these, he states soap and water is the best; the ointment of calomel is not practical at all. "Since advising soap and water I have for thirty years no more cases of venereal disease among my guards" (*The Lancet,* November 3, 1917). With this opinion most authorities today agree. The value of such prophylactics as soap and water and urination after intercourse is that they are practical and their use can be enforced with some success.

All authorities agree that it is a mistake to rely too much on any of the chemical agents—calomel, bichloride, injections of silver salts. A great change has taken place in medical opinion. From the exhaustive account of prophylaxis in the articles of Blaschko in the *Deutsche Strafrechtszeitung* and other journals, it is clear that the present Teuton program is much the same as the British. In addition, he would abolish houses of prostitution, being in favor of what is called neo-reglementation, under which both sexes are treated alike, and men would be examined for venereal diseases before marriage. As to toleration and medical inspection, he believes that their merits are greatly overestimated. "The doctor's certificate," he says, "does not guarantee safety." Apparently the war has had the effect of making many medical illusions fade away. Blaschko's opinions seem to be the prevailing ones in Germany today, as the recent meetings at Mannheim and in Galicia indicate.

The war has had another effect. The advance in our knowledge of antiseptics has caused a notable change in the position of calomel. It is too insoluble to be an effective or even a trustworthy prophylactic for syphilis and gonorrhea. In a recent number of the *Annales des Maladies Vénériennes,* Gaucher states that its effect is uncertain—whether it

be applied in the strength of ten, thirty, or fifty per cent. in lanoline and vaseline, whilst its use before intercourse is an incentive to take risks. "It is to be feared," he writes, "that the prophylactic packet will be a danger by giving the interested a sense of false security."

The upshot of all these reports and discussions is that there has been a progressive increase in the precision and success with which hygienic methods have been employed. Venereal clinics and instruction centers are now established in England and Germany, and in Germany punishment is meted out to those who infect others. The best methods by which venereal diseases can be attacked are now considered moral and hygienic and penal. Obviously, if those contaminated with syphilis and gonorrhea could be prevented from infecting others, much venereal disease would disappear.

THE ONE HUNDRED AND FOURTH ANNUAL REPORT OF THE MASSACHUSETTS GENERAL HOSPITAL.

The one hundred and fourth Annual Report of the Massachusetts General Hospital, including, besides the General Hospital in Boston, the McLean Hospital and the Convalescent Hospital in Waverley, has been submitted for the year 1917. The past year has been an eventful one, for many changes have been made necessary because of the active participation of many members of the staff in war service.

Both because of the absence of so many who are engaged in military work and because of the need of economy, a number of departments —including the Convalescent Hospital, the Cement Shop, the Industrial, Psychiatric, and Consultation Clinics, and the Hydrotherapeutic and the Medico-Mechanical Rooms—have of necessity been temporarily closed. Despite, however, this curtailment, the various departments have been supported by the efficient coöperation of their members, and have rendered satisfactory and increased services to the patients and the community.

The report of the General Hospital shows a patriotic response to the demands upon its services. In July, a unit was organized for service abroad, and is now serving in France as the United States Army Base Hospital No. 6. under the command of Major Frederic A. Washburn. This unit consists of twenty-six officers, sixty-six nurses, and one hundred and fifty-five enlisted civilians. The Hospital is grateful to the American Red Cross Society for the financial support which it furnished in the preparation and transport of the unit.

In response to a request made by the Commandant of the Naval Hospital in Chelsea, patients from the enlisted force of the Navy and Marine Corps have been accepted since October.

In order to conform with the requirements of the War Department, the term of service of surgical and medical internes has been temporarily shortened, in order to make hospital-trained physicians available for military service as soon after graduation as practicable.

The Nursing Department, in addition to the regular work of the Training School, has admitted to its wards for ten days' practice work seventy-four Red Cross Nurses' aids.

The Out-Patient Department, although the war has deprived it of twenty-eight members of its staff, has been able to maintain its usual high standards. Notwithstanding the fact that the size of the clinics has been considerably reduced, the total amount accomplished during the year shows an increase compared with previous years.

The Roentgenological Department has been able to increase the efficiency of its work by the additional space and equipment which has been made available. This department has been opened to physicians who are engaged in x-ray work, in order to offer to radiologists of smaller towns and hospitals an opportunity to work in a large clinic where problems in technic and diagnosis can be studied.

In the Medical Department, investigative work has been very largely held up because of war conditions. In the Children's Medical Service Department, however, investigations are still being conducted. Other departments, particularly the Surgical and Orthopedic Departments, have been deprived by the war of many members of their staffs, but have been conducted, nevertheless, with satisfactory service. The Syphilis and Dermatological Departments have conducted active and satisfactory work throughout the year. The clinics for pulmonary and non-pulmonary tuberculosis had many new patients, and the infantile paralysis clinic has been of great service. The usual work of the pathological laboratory has been carried on as in previous years.

A private ward has been opened in Phillips House for the reception of patients who have the right to employ their own physicians, provided they are members of the hospital staff or alumni. A portion of this ward is devoted to the Maternity Department.

The work of the Social Service Department has been increased considerably because of the closing of the Convalescent Hospital at Waverley. The Ladies' Visiting Committee has rendered valuable service to this department.

The one hundredth report of the McLean Hospital shows limitation in its medical work because of the enlistment of one-half of its medical staff in the service. The medical work presents, however, several features of interest, specially in the treatment of general paralysis by both intravenous and intraventricular methods, and in the treatment of cerebrospinal meningitis by intraspinal and intraventricular administration of antimeningitis serum.

Detailed information and statistics concerning the reports of the various departments of the Hospital may be found in the Annual Report.

The financial situation of the Hospital has felt the strain of the demands which the war has necessitated. The increased cost of everything used in the Hospital has resulted in a deficit, in spite of the severest economy which has been practised. The Hospital is indeed grateful for the donations to the general fund of over $28,000, and to the restricted fund of more than $84,000. Appreciation is also expressed for the voluntary services which have been given to the Hospital.

In looking forward to the future development of the Hospital, it is felt that a great effort should be made to render its expensive equipment and scientific organizations available to all classes for professional services. It is particularly urgent that the problem of providing for the large middle class in the community be solved. All citizens of Massachusetts are earnestly implored to give all they can toward the support of this great charitable service.

MASSACHUSETTS SCHOOL OF PUBLIC HEALTH.

A NEARLY complete list of speakers for the Four-Day Free School of Public Health, to be conducted by the Massachusetts Medical Society, with the coöperation of the State Department of Health, the Massachusetts Association of Boards of Health, and the U. S. Public Health Service, is as follows:

Prof. Robert Spurr Weston, Consulting Sanitary Engineer; Mr. M. C. Whipple, Instructor in Sanitation at Harvard University; Mr. Harry W. Clark, State Department of Health; Dr. Francis H. Slack, Instructor in Diagnostic Laboratory Methods in the Harvard-Technology School of Public Health; Miss Edith A. Beckler, Bacteriologist of the State Department of Health; Mr. A. W. Hedrich, Secretary of the American Public Health Association; Dr. J. P. Bill, Instructor in Preventive Medicine at Harvard Medical School; Mr. John Ritchie, Jr., Former Health Commissioner of Boston; Prof. G. C. Whipple, Massachusetts Institute of Technology; Dr. John S. Hitchcock, Director of the Division of Communicable Diseases, State Department of Health; Dr. Walter E. Fernald, in charge of the Massachusetts School for the Feeble-Minded; Dr. John B. Hawes, Secretary of the State Anti-Tuberculosis Association; Dr. David L. Edsall, Specialist in Industrial Hygiene; Passed Assistant Surgeon A. J. Lanza of the U. S. Public Health Service; Prof. P. G. Stiles of Harvard Medical School; Dr. W. W. Peter, Director of Public Health Education in China; Dr. Dorothy Reed Mendenhall of the Children's Bureau; Dr. George H. Wright, Lecturer in the Harvard Dental School; Dr. L. D. Bristol, Health Commissioner of the State of Maine; Miss Anne H. Strong, Assistant Professor of Public Health Nursing, Simmons College; and Dr. E. R. Kelley, Sate Commissioner of Health.

MEDICAL NOTES.

MATERNAL NURSING AND THE WAR.—According to Dr. Julius Levy, director of child hygiene, New Jersey, an increase of two months in maternal nursing would be of considerable aid to the war. This program would make available for war purposes 140,625,000 quarts of milk, 14,062,500 pounds of sugar, and 2,500,000 bottles, in addition to the fuel and other utensils required in the preparation of milk for infant consumption. This would represent an outlay by the mothers of the country of at least $25,612,500. Dr. Levy affirms that the

adoption of this principle would also increase the happiness of mothers and insure the life and health of the children.

PARIS ANTI-CANCER INSTITUTE.—An Anti-Cancer Institute will be founded soon in Paris. It will be similar to those working in London, New York, and Chicago, and to the one established by Czerny at Heidelberg. All patients, rich or poor, suffering from tumors, will receive the care required for each particular case. There will be laboratories for the use of students, regardless of their nationality, who are interested in the study and treatment of cancer.

INFANT DEATH RATE IN NEW ZEALAND.—The infant death rate in New Zealand is the lowest in the world. How this is accomplished has been explained by Dr. F. Truby King, a physician of that country. For the past twelve years, there has been manifested in New Zealand an increasing interest in the welfare of mothers and children, with a result that the infant death rate has been reduced to 5%, and the health of survivors has been greatly improved.

This work in New Zealand was begun by private individuals; but it was soon increased by the formation of a voluntary society called the "Society for Health of Women and Children," or the "Plunket Society." The first branch was formed in Duneden, and consisted of a committee of twenty-five earnest and capable women. There are now eighty branches. A little later, the Government became interested and granted subsidies of one dollar for each dollar privately subscribed toward the payment of trained nurses sent out by the Society. The Government has now increased its assistance by granting subsidies of six dollars for every five dollars voluntarily subscribed, by subsidizing the society's baby hospital, by granting free passes over government railways, and by the publishing and issuing of pamphlets. This work is untouched by politics; it is the result of the utmost devotion and enthusiasm of the various committees. The newspapers have been an important factor in the success of this infant welfare work, and should be commended for their coöperation.

WAR NOTES.

WOUNDED SOLDIERS FROM FRANCE.—One hundred and thirteen sick and wounded soldiers, of the American Expeditionary Forces, were landed in the United States during the week ending Friday night, April 26.

APPOINTMENT OF MAJOR BOGAN.—Major Frederick L. Bogan, of Boston, has been appointed commanding officer of the 102d field hospital, the highest rank next to that of division surgeon.

SOUVENIRS FROM FRANCE.—Dean Bradford, of the Harvard Medical School, has received from Dr. Harvey Cushing, head of the Harvard medical unit in France, a collection of souvenirs, including several pathological specimens from cases of cranial injury. These gifts will be placed in the Warren Museum.

APPOINTMENT OF DR. LEE.—Major Roger I. Lee, chief medical officer of the Harvard surgical unit which sailed almost a year ago, has been appointed commanding officer in place of Col. Patterson.

ARMY HEALTH CONDITIONS.—The number of deaths last week was 251, against 208 the previous week. Pneumonia was not so prevalent. In the Regular Army and the National Guard, the number of deaths has increased, but the National Army shows decrease from 160 to 113. In the aviation section, nine deaths have resulted from accidents.

PROMOTION OF DR. WHEATON.—Dr. James L. Wheaton, of Pawtucket, R. I., has been promoted to the rank of major in the Medical Corps of the Regular Army.

SMITH COLLEGE UNIT.—The American college girls of the Smith College unit have displayed conspicuous bravery in attending the wounded and civilians under fire during the recent German advance. The girls have been engaged in the work of rehabilitation in the Somme district. Because of the advance of the enemy, they have been forced to retreat to Verlaine and Esmery-Hallon, where they have rendered admirable service in the care of old refugees and children.

During the German drive, the unit has lost its entire equipment, with the exception of three motor cars. The girls have been praised especially for their work just before the Germans reached Ham. They not only evacuated their own villages, but assisted in the evacua-

tion of the Nesle Hospital. As soon as they reached Montdidier, a coffee station was improvised, and a temporary children's hospital was installed in a hotel.

Later the Red Cross asked for helpers for Amiens, and five of the girls were chosen. During their first night, the town was bombed again and again by the Germans. Half of their time was spent in cellars and the other half in rendering what services they could to the civilians. Finally, the girls were forced to move to another town, where they offered their services to the French authorities and helped to feed the wounded who were passing through the town. While awaiting further opportunities to be of service, the girls have been engaged especially in visiting English-speaking wounded in several of the hospitals, giving them cigarettes, writing letters for them, and attending to their wants.

The girls have worked hard and have been in constant danger, but all declare that they would gladly begin the work all over again.

BOSTON AND MASSACHUSETTS.

WEEK'S DEATH RATE IN BOSTON.—During the week ending May 4, 1918, the number of deaths reported was 275, against 266 last year, with a death rate of 18.28, against 17.96 last year. There were 42 deaths under one year of age, against 40 last year.

The number of cases of principal reportable diseases were: diphtheria, 59; scarlet fever, 33; measles, 326; whooping cough, 45; tuberculosis, 84.

Included in the above were the following cases of non-residents: diphtheria, 13; scarlet fever, 14; measles, 9; whooping cough, 1; tuberculosis, 2.

Total deaths from these diseases were: diphtheria, 4; scarlet fever, 1; measles, 6; whooping cough, 5; tuberculosis, 30.

Included in the above were the following non-residents: diphtheria, 1; measles, 1; whooping cough, 1; tuberculosis, 1.

NEW ENGLAND ROENTGEN RAY SOCIETY.—A meeting of the New England Roentgen Ray Society was held at Camp Devens May 4. The society was the guest of Major Ernest L. Davis, who read a paper based on his study of a large number of lung conditions, especially in cases of pneumonia. Major Lewis Gregory Cole of Base Hospital No. 1 (New York) was a guest of the Society and led the discussion of Major Davis' paper.

NEW HARVARD DEAN.—Dr. Algernon Coolidge has been made acting dean of the Graduate School of Medicine and acting chairman of the College Library Council. Dr. Coolidge is taking the place of Dr. Alexander S. Begg, who is now in active service.

DENTAL CLINIC DESTROYED.—The dental clinic at the Tufts Medical School has been destroyed by fire, with a damage amounting to $25,000. The students aided in saving the fittings of the dental room and the property used for research purposes. The work of the clinic will be carried on in another building.

MASSACHUSETTS SOCIETY OF EXAMINING PHYSICIANS.—The Massachusetts Society of Examining Physicians at its annual meeting at the Copley-Plaza, on April 26, 1918, elected the following officers:

President, Dr. Frank E. Schubmehl, General Electric Company, Lynn.

Vice-Presidents, Dr. Herbert H. Howard, Boston; Dr. C. S. Benson, Haverhill; Dr. John E. McCartin, Boston.

Secretary, Dr. J. H. Stevens.

Treasurer, Dr. John S. Phelps.

Councillors, Dr. F. J. Cotton, Boston; Dr. J. F. Edgerly, Lincoln; Dr. W. P. Coues, Boston; Dr. F. J. Hanley, Whitman; Dr. R. C. Gwynn, Boston.

The Society voted to oppose Senate Bill No. 345, which proposes to give the re-education and rehabilitation of injured industrial workers to the State Board of Education. It was the sense of the Society that such power should be conferred upon the Industrial Accident Board.

HOME FOR AGED WOMEN, BOSTON.—The sixty-eighth annual report of the Home for Aged Women, Boston, has been submitted for the year 1917. The death of two of its members, Miss Sarah H. Crocker, one of the vice-presidents, and Miss Zilla Baker, head nurse, is recorded with regret.

The health of the inmates of the Home has been better than could reasonably be expected. The number of infirm cases has gradually increased, due largely to the increased minimum age requirement.

There has been an average of 88 inmates throughout the year. There are 137 on the waiting list.

During the year, the women of the Home have engaged in war work with remarkable energy, and have completed nearly three thousand articles of various kinds.

The Home has received bequests amounting to over $35,000. The friends of the Home are earnestly urged not to forget the growing needs of this institution.

Miscellany.

COUNCIL OF NATIONAL DEFENSE.

Some of the Activities and Interests of the General Medical Board of the Council of National Defense, April, 1917-April, 1918, as Reported at the Annual Meeting, Sunday, May 5, 1918, New Willard Hotel, Washington, D. C.

The following statement, which is authorized by the Medical Section of the Council of National Defense, is a brief summary of the report of Dr. Franklin Martin, member of the Advisory Commission and chairman of the General Medical Board of the Council of National Defense, with mention of some of the leading interests and activities of the year of the Board and of the Medical Section, presented at the annual meeting of the General Medical Board, May 5, 1918.

GENERAL.

Secretary of War Baker, on April 2, 1917, authorized appointment of General Medical Board. Dr. Martin designated 35 physicians and surgeons, many of whom have since entered on active service abroad. Total now is 77. Executive Committee consists of Surgeons-General of Army, Navy, and Public Health Service, Dr. Franklin Martin, Dr. W. J. Mayo, Dr. William H. Welch, Dr. Victor C. Vaughan, Dr. F. F. Simpson, Rear Admiral Cary T. Grayson, and Dr. William F. Snow, Secretary. The first meeting was held April 9, 1917.

Requested medical men returning from abroad to furnish information regarding conditions observed in medical services of allied armies, which information was carefully summarized for reference.

Responded to request of Surgeon-General to assist in increasing enrollment in Medical Reserve Corps. Enrollments in M.R.C. have been increased from 1800 in April, 1917, to over 21,000, of which 16,042 are on active duty.

Requested 50 medical societies to furnish lists of their members fitted to perform special work for Government.

CHILD WELFARE.

Formed Committee on Child Welfare, comprising representatives of several government departments, educational institutions and national organizations, to coördinate child welfare activities, and formulated program covering problems of the child up to school age, which program has been issued to the states through the medium of the States Council Section and the Woman's Committee of the Council of National Defense.

Appointed committees: (*a*) to study best graphic methods of teaching child welfare; (*b*) to study food values necessary to children and prepare dietaries; (*c*) to report best procedure as to mid-wife question in present war emergency; and (*d*) to consider advisability of investigation of institutions caring for children.

CIVILIAN COÖPERATION IN COMBATING VENEREAL DISEASES.

Developed joint conferences of medical and lay citizens in 50 cities with officials, to discuss plans for venereal disease clinics or law enforcement measures.

Formulated list of eight measures essential to successful campaign against venereal diseases, and sent to State Boards of Health.

Appealed to State Pharmaceutical Associations for Boards of Pharmacy to assist in eliminating sale of nostrums.

Arranged trips for lecturers who aided Boards of Health in 30 states, and stimulated them to more vigorous work.

Partially as a result of correspondence with State Boards of Health, 26 states have adopted measures requiring reporting of venereal diseases, 9 have special venereal bureaus, 14 provide free laboratory diagnosis, 6 provide arsphenamine, practically or absolutely free. Only 7 states classified as complacent.

Partially as a result of letters to 1000 mayors, 49 cities provide for isolation and treatment of venereal cases, 51 require reporting of venereal diseases, 43 have clinics, 78 are conducting educational work.

Informed editors of health bulletins and la-

bor journals of details of campaign against venereal diseases.

Distributed printed material and sent personal and circular letters to thousands of persons in communities adjacent to army camps, enlisting their coöperation.

DENTISTRY.

Appealed to dental profession through various dental associations, materially increasing enrollment in Dental Officers' Reserve Corps.

Instrumental in having military instruction included in curricula of dental colleges, and in having applicants for enrollment in Dental Surgeons Corps specially trained.

Coöperated with manufacturers in having dental instruments and supplies standardized.

Secured volunteer services of civilian dental profession in eliminating dental disabilities of recruits.

Recommended improved courses in dental surgery in Army and Navy medical schools.

Initiated investigation as to relation of trench mouth disease to oral and general disease.

Dental Committee recommended higher rank for dentists in Army Dental Corps.

HOSPITALS.

Recommended to general hospitals reorganization of staffs, in order to release as many as possible for Army and Navy service, and urged each person whose services could be spared to apply for appointment.

Hospitals classified exhaustively as to size, convenience to transportation, equipment, and all other details.

Investigated subject of portable hospitals, and recommended purchase of a limited number by the Surgeon-General of the Army.

Classified and tabulated for use of Surgeon-General's office data as to private houses and large buildings offered for use as military hospitals.

HYGIENE AND SANITATION.

Recommended to War and Navy Departments that zones around camps and cantonments be placed under military control in order to protect troops from venereal infections. Encouraged organization of Fosdick Commissions or Training Camp Activities.

Appointed sub-committees on drug addictions, alcoholic control, public health nursing, tuberculosis, and health statistics, which committees have assembled information and recommended definite sanitary measures for guidance of Army, Navy, Public Health Service, American Red Cross, and Civil Health Agencies.

Work of sub-committee on venereal diseases has expanded, and it has become the Committee for Civilian Coöperation in Combating Venereal Diseases, a general committee of the General Medical Board.

INDUSTRIAL MEDICINE AND SURGERY.

Instituted an Advisory Committee on Industrial Hygiene, comprising representatives from Public Health Service, Departments of Agriculture, Interior, Commerce, Labor, and of Organized Industry, Organized Labor, Organized Medicine, and Organized Industrial Medicine, for the purposes of providing against unnecessary human waste in industry and society during war, to offset drain of man-power from industry through raising of military forces to meet need for increased production, to avoid preventable deaths from accidents and disease, and to improve surroundings of workers.

LEGISLATION.

Drafted Section of Army Bill eliminating sale of alcoholic drinks and prostitution in five-mile zone around camps and cantonments; indorsed by Council of National Defense, and enacted into law within ten days of original rough draft.

Induced authorities to provide for enlistment of medical students of well-recognized schools in Enlisted Medical Reserve Corps, and completion of course before being called into military service. Similar effort made in aid of premedical students.

Instrumental in having American concerns licensed to manufacture salvarsan, and other German-owned medicinal preparations. Quantity previously sold for $4.00 now furnished Government at $1.00.

Made considerable effort to have rank of medical officers made commensurate with the service which the nation expects from the profession.

MEDICAL SCHOOLS.

Urged students to continue medical education so that upon entering government service they might be fully trained; also urged students to

apply for commissions in Medical Reserve Corps upon graduation.

Urged schools to release teachers for enrollment in Medical Reserve Corps.

Asked heads of educational institutions to advise pre-medical students to enroll in medical schools of their choice as soon as possible.

Asked medical schools to allow fourth-year students to substitute senior year in base hospital instead of school, if emergency arises.

MEDICAL WAR MANUALS.

Published four war manuals: 1, "Sanitation for Medical Officers," by Edward B. Vedder, M.D., Lieut.-Col., M.C., U.S.A.; 2, "Notes for Army Medical Officers," by T. H. Goodwin, Lieut.-Col., R.A.M.C.; 3, "Military Ophthalmic Surgery," by Allen Greenwood, Major, M.R.C., G. E. de Schweinitz, Major, M.R.C., and Walter R. Parker, Major, M.R.C., and, 4, "Military Orthopedic Surgery," by the Orthopedic Council.

These also are ready for publication: "Surgery of the Zone of Advance," by George de Tarnowsky, Major, M.R.C.; "Notes on Military Surgery," by George W. Crile, Major, M.R.C., and "Lessons from the Enemy," by John McDill.

NURSING.

Instrumental in increasing by 20% number of pupil nurses in training schools, by means of correspondence with college and school graduates, deans of women's colleges, school principals and Board of Education secretaries.

Distributed about 100,000 bulletins and leaflets for information of prospective students.

Made nation-wide survey of country's nursing resources, and urged heads of training schools and hospitals to increase their facilities.

Published series of 12 articles on nursing in newspapers throughout the country.

Instrumental in having nurses included in War Risk Insurance Law.

Secured evidence of need for military rank for nurses, and secured indorsements of this movement from many persons.

Conducted campaign for increasing number of candidates for nursing education.

Coöperated in preparing details of preparatory nursing course for college graduates at Vassar College.

Recommended to Surgeon-General of the Army that increased accommodations for nurses be made at camps, that not less than one nurse be provided to six acutely ill men, that there be a reserve of not less than 25 nurses at each camp hospital, and that a qualified nurse tour military and naval hospitals to make observations; all of which recommendations have been favorably received. Miss Annie W. Goodrich appointed Inspector-General of Nursing Service in all military hospitals in the United States and France.

Recommended to superintendents of training schools to speed instruction and hold final examinations and graduations early in 1918, and release graduates for government service.

Coöperated with Red Cross and with National Organization for Public Health Nursing in enrollment of public health nurses in office of Red Cross, and urged public health nursing agencies to release staff members for service in extra-cantonment zones and for rehabilitation work in France and Belgium.

Coöperated with Food Administration in having public health nurses instructed in preparation of war-time food substitutes.

RE-EDUCATION AND REHABILITATION.

Presented to Secretary of War plan for formation of Reconstruction Board, including representatives of Army, Navy, Public Health Service, Red Cross, Council of National Defense, Hospitals and Laboratories, Medicine and Surgery, Vocational Education, Labor and Industry. Secretary of War instructed Surgeon-General to call conference and formulate plan. As a result bill was drafted providing for vocational rehabilitation and return to civil employment of soldiers and sailors disabled in line of duty.

RESEARCH.

Instituted investigation of conditions under which canned foods become deleterious.

Was instrumental in having University of Minnesota grow a supply of digitalis adequate for America's needs, to replace supply hitherto obtained from Germany.

Instituted tests of devices aimed to protect the ear from injuries by explosives.

Examined and card-indexed numerous antiseptics and disinfectants, furnishing all information to Medical Supply Department of the Army. Valuable cocaine substitutes and cheap disinfectants found usable. Silenced claims of venders of large number of absolutely worthless preparations.

Placed subject of shell shock in hands of Dr. George W. Crile for study.

Instrumental in bringing into use several substitutes for ambrine, for treatment of burns.

Instituted study which led to discovery that various preparations of thromboplastin help prolong period for coagulation of blood.

Investigated various devices for preparations for sterilizing wounds and germ carriers.

Instituted study of processes for sterilizing drinking water which led to authoritative statement that use of chlorine is best means, chlorine now being used under all conditions.

Instrumental in having prepared authoritative review of war literature bearing upon injuries of the peripheral nerves.

Abstracted all obtainable literature on methods of destroying lice, and instituted experimental research.

Instrumental in having published critical review of methods and results of vaccination for smallpox.

Obtained from a noted French authority statement of results obtained by French investigators as to value of Widal test after vaccination for typhoid fever.

STANDARDIZATION.

Held frequent conferences to study means by which production might be speeded, and demand for diverse types of appliances might be curtailed.

Conferences participated in by representatives of Army, Navy, Red Cross, Public Health Service, and manufacturers of surgical instruments and supplies. Result: Substantial increase in production of staple articles, standardization in types and issuance of four catalogues of staple medical and surgical instruments and supplies for use of Army, Navy and Red Cross.

STATES ACTIVITIES.

Obtained though State and County Committees names of physicians: (*a*) available for service in the Medical Reserve Corps, (*b*) those not available because of physical disability, over-age (55), or because of home community need.

Requested coöperation of medical profession in asking aid of Senators and Congressmen for legislation in reference to advanced rank for medical officers.

Made survey of medical schools, as a result of which arrangements were made for enlistment of medical students of well-recognized schools in enlisted Medical Reserve Corps and placing them on inactive list until completion of their medical education. Similar effort made in aid of pre-medical students.

Organized Volunteer Medical Service Corps for physicians ineligible to Medical Reserve Corps, because of physical disability, over-age, or essential home community need.

Prepared and mailed monthly to State and County Committees percentage tables of recommendations by Surgeon-General for commissions in Medical Reserve Corps.

Coöperated with Provost Marshal General's Office in selecting members of Medical Reserve Corps as medical aides to governors. Formulated outline of duties of medical aides.

Coöperated in having representatives sent to 44 states urging membership in Medical Reserve Corps.

Classified membership records of Medical Reserve Corps from code cards, a set being furnished for the Surgeon-General's Office in Washington and a set for the representative of the Surgeon-General with General Pershing's Army in France.

Made survey, through a sub-committee, of ophthalmologists of country, and requested those not needed for institutional and civic needs to join M.R.C.

Same committee standardized methods of eye examinations. Held conference on reeducation of blind soldiers, and conducted survey of workshops for the blind.

Made survey and classified, through a subcommittee, the otolaryngologists of country (brain, oral and plastic surgeons), requesting those available to join Medical Reserve Corps.

Recommended that specialists in head surgery be assigned to special duty in military hospitals; also that special hospitals be assigned for treatment of eye, ear, nose and throat cases; also recommended definite number of surgeons and assistants of each specialty, for chief hospitals and for each military division.

WOMEN PHYSICIANS.

Prepared index and complete data as to all women physicians in the United States.

Prepared lists of anesthetists, laboratory workers, radiographers, sanitarians, specialists, and industrial surgeons, willing to serve.

Compiled data regarding recent graduates of 35 co-educational medical colleges.

Secured registration of 1875 women physicians willing to serve—more than one-third of the total number in the United States.

THE GENERAL MEDICAL BOARD OF THE COUNCIL OF NATIONAL DEFENSE.

The Council of National Defense is composed of six members of the President's Cabinet—the Secretaries of War, Navy, Interior, Agriculture, Commerce and Labor. The Council nominated, and the President appointed an Advisory Commission of seven specially qualified persons, each having knowledge of one great field. Dr. Franklin H. Martin, as chairman of the Committee on Medicine and Sanitation of the Commission, organized the General Medical Board for the purpose of aiding in the enormous expansion of the various government bureaus and coördinating with their work the resources and talent of the civilian medical profession. Through this Board, which thus has its authority in the Advisory Commission and which represents the civilian population in its relation to the four government administrative offices of the Surgeons-General of the Army, Navy, Public Health Service and the Red Cross, "the organization for war of the medical profession," one of the set objects of the Council, is being carried out. This body originally consisted of 35 of the strongest medical men who could be selected. Ten of the original members have gone abroad on active service. The Board now has 77 members, including officers of principal surgical and medical societies, officers of the Army, Navy, and Public Health Service and a representative of the Red Cross, and 22 of these are on active duty in Washington. Recommendations are made to it, and medical questions referred to it for discussion. Such medical problems as develop from the activities of the committees of the Medical Section—the Board's operating body, of which Major F. F. Simpson is chief—are considered at the monthly meetings of the Board, usually held on Sunday, and referred, if deemed advisable, to the Monday morning meetings of the Executive Committee of ten, which includes the Surgeons-General of the Army, Navy and Public Health Service, the Chairman and Vice-Chairman of the Board, Lieutenant-Colonel Victor C. Vaughan, Lieutenant-Colonel William H. Welch, Major William J. Mayo, Rear-Admiral Cary T. Grayson, and Major William F. Snow, Secretary. If a recommendation of a committee is approved by the Executive Committee, it is laid before the Advisory Commission or the Council of National Defense, or both, by Dr. Martin, who is thus the link between the profession and the President's Cabinet. In this way there is official, executive action. If approved, the recommendations, for final working out, are referred back to the General Medical Board, or distributed in the way of information to those in authority in the bureaus concerned. The General Medical Board keeps in touch with all State and County Committees, and through them with all the sectional medical societies.

MEMBERS OF THE GENERAL MEDICAL BOARD.

On Active Duty in Washington.

Dr. Franklin Martin, Chicago, Illinois, Member of Advisory Commission, Council of National Defense, Chairman.

Dr. F. F. Simpson, Pittsburgh, Pennsylvania, Chief of Medical Section, Council of National Defense, Vice-Chairman.

Dr. W. F. Snow, New York City, Professor Public Health, Stanford University, Surgeon General's Office, Secretary.

Surgeon General William C. Gorgas, U. S. Army.

Surgeon General William C. Braisted, U. S. Navy.

Surgeon General Rupert Blue, U. S. Public Health Service.

Rear Admiral Cary T. Grayson, U. S. N., Washington, D. C.

Dr. William J. Mayo, Rochester, Minn.

Dr. Victor C. Vaughan, Dean of Medical Department, University of Michigan, Ann Arbor, Mich.

Dr. William H. Welch, Professor of Pathology, Johns Hopkins University, Baltimore, Md.

Dr. Elliot G. Brackett, Asst. Professor of Orthopedic Surgery, Harvard Medical School, Boston, Mass.

Dr. Philip Schuyler Doane, Chicago, Illinois.

Dr. Seale Harris, Secretary Southern Medical Association, Birmingham, Alabama.

Dr. Henry D. Jump, Asst. Physician, Philadelphia General Hospital, Philadelphia, Pa.

Dr. Allen B. Kanavel, Associate Professor of Surgery, Northwestern Univ. Medical School, Chicago, Ill.

Dr. W. H. G. Logan, President-elect, National Dental Association, Chicago, Illinois.

Dr. Charles H. Mayo, President, American Medical Association, Rochester, Minn.

Dr. John D. McLean, Member of Staff, Rush Hospital, Philadelphia, Pa.

Dr. James Bordley, Jr., Surgeon in charge, S. Balto. Eye Hosp., Baltimore, Md.

Professor Earle Phelps, Sanitary Engineer, Washington, D. C.

Dr. George E. deSchweinitz, Professor of Ophthalmology, University of Pennsylvania, Philadelphia, Pa.

Dr. Winford H. Smith, Superintendent, Johns Hopkins Hospital, Baltimore, Md.

Dr. Hubert Work, Pueblo, Colorado, Chairman, House of Delegates, American Medical Association.

ON ACTIVE DUTY ABROAD.

Dr. Frederic A. Besley, Professor of Surgery, Northwestern University, Chicago, Illinois.
Dr. George E. Brewer, Professor of Surgery, Columbia University, New York City.
Dr. George W. Crile, Professor of Surgery, Western Reserve University, Cleveland, Ohio.
Dr. John M. T. Finney, Professor of Clinical Surgery, Johns Hopkins University, Baltimore, Md.
Dr. Joseph M. Flint, Professor of Surgery, Yale University, New Haven, Conn.
Dr. Joel E. Goldthwait, Lecturer on Orthopedics, Harvard Medical School, Boston, Mass.
Dr. Charles H. Peck, Professor of Surgery, Columbia University, New York City.
Dr. Richard P. Strong, Professor of Tropical Medicine, Harvard University, Boston, Mass.
Dr. William S. Thayer, President, Congress of American Physicians and Surgeons, Baltimore, Md.
Dr. George Walker, Associate in Surgery, Johns Hopkins University, Baltimore, Md.

ON ACTIVE DUTY IN CAMPS OR OTHER SERVICES IN THIS COUNTRY.

Dr. John Fairbairn Binnie, Recorder, American Surgical Association, Kansas City, Mo.
Dr. Joseph C. Bloodgood, Associate Professor of Surgery, Johns Hopkins University, Baltimore, Md.
Dr. John Young Brown, Professor of Surgery, University of St. Louis, St. Louis, Mo.
Dr. Joseph Rilus Eastman, President, Western Surgical Association, Indianapolis, Ind.
Dr. William D. Haggard, Professor of Surgery, Vanderbilt University, Nashville, Tenn.
Dr. Fred Bates Lund, Lecturer on Surgery, Harvard Medical School, Boston, Mass.
Dr. Edward Martin, Professor of Surgery, University of Pennsylvania, Philadelphia, Pa.
Dr. Stuart McGuire, Professor of Surgery, Medical College of Virginia, Richmond, Va.
Dr. Albert J. Ochsner, Professor of Surgery, University of Illinois, Chicago, Illinois.

OTHER MEMBERS.

Dr. Thomas W. Huntington, Professor of Surgery, University of California, San Francisco, Cal.
Dr. Alexander C. Craig, Secretary, American Medical Association, Chicago, Illinois.
Dr. John B. Deaver, Professor of Practice of Surgery, University of Pennsylvania, Philadelphia, Pa.
Dr. Simon Flexner, Director, Rockefeller Institute for Medical Research, New York City.
Dr. Hobart Amory Hare, Professor of Therapeutics, Materia Medica and Diagnosis, Jefferson Medical College, Philadelphia, Pa.
Dr. C. Jeff Miller, Professor of Obstetrics and Clinical Gynecology, Tulane University, New Orleans, La.
Dr. Hubert A. Royster, Secretary, Southern Surgical Association, Raleigh, N. C.
Dr. George H. Simmons, Editor *Journal of American Medical Association*, Chicago, Illinois.
Dr. J. Bentley Squier, Professor of Urology and Genito-Urinary Surgery, College of Physicians and Surgeons, Columbia University, New York City.
Dr. Herman M. Biggs, State Commissioner of Health, New York City.
Dr. Alexis Carrel, Member of Staff, Rockefeller Institute, New York City.
Dr. John G. Clark, Professor of Gynecology, University of Pennsylvania, Philadelphia, Pa.
Dr. Frederic J. Cotton, Associate in Surgery, Harvard Medical School, Boston, Mass.
Dr. Thomas S. Cullen, Vice-President, Southern Surgical and Gynecological Assn., Baltimore, Md.
Dr. Edward P. Davis, Professor of Obstetrics, Jefferson Medical College, Philadelphia, Pa.
Dr. Robert L. Dickinson, First Vice-President, American Gynecological Society, Brooklyn, N. Y.
Dr. William A. Evans, President, American Public Health Association, Chicago, Illinois.
Dr. Duncan Eve, Sr. President, Southern Medical Association, Nashville, Tenn.
Dr. S. S. Goldwater, Superintendent, Mt. Sinai Hospital, New York City.
Dr. S. McC. Hamill, Professor of Pediatrics, University of Pennsylvania, Philadelphia, Pa.
Dr. Malcolm L. Harris, Secretary, Board of Trustees, American Medical Association, Chicago, Ill.
Dr. Jabez Jackson, Kansas City, Mo.
Dr. Charles E. Kahlke, Professor of Surgery, Hahnemann Medical College, Chicago, Ill.
Dr. John H. Landis, Health Commissioner, Cincinnati, Ohio.
Dr. John A. Lichty, Professor of Medicine, University of Pittsburgh, Pittsburgh, Pa.
Dr. Rosalie Slaughter Morton, Chairman, American Women's Hospitals, New York City.
Miss M. Adelaide Nutting, Professor of Nursing and Health, Teachers' College, Columbia University, New York City.
Dr. Charles B. Penrose, Professor of Gynecology, University of Pennsylvania, Philadelphia, Pa.
Dr. Emmet Rixford, Professor of Surgery, Stanford University Medical School, San Francisco, Cal.
Dr. Sterling Ruffin, Professor of Medicine, George Washington University, Washington, D. C.
Dr. George David Stewart, Professor of Surgery, University Bellevue Hospital Medical College, New York City.
Dr. William B. Van Lennep, Professor of Surgery, Hahnemann Medical College, Philadelphia, Pa.
Dr. Florence N. Ward, Chief Surgeon, Florence N. Ward Sanatorium, San Francisco, California.
Dr. Ray L. Wilbur, President, Stanford University, San Francisco, California.
Dr. W. C. Woodward, Health Officer of the District of Columbia, Washington, D. C.
Dr. Katharine B. Davis, Executive Secretary, Bureau of Social Hygiene, Rockefeller Foundation, New York City.

HONORARY MEMBERS.

Colonel C. U. Dercle, Medical Department, French Army, Paris, France.
Colonel T. H. Goodwin, Surgeon General, R. A. M. C., London, England.
Mr. Julius Rosenwald, Member of Advisory Commission, Council of National Defense, Chicago, Ill.
Colonel Claude K. Morgan, British Army Medical Service, London, England.

THE COMMITTEES OF THE GENERAL MEDICAL BOARD OF THE COUNCIL OF NATIONAL DEFENSE ARE:

Executive Committee.

(The Central Governing Board has in charge the organization of the Volunteer Medical Service Corps, and is made up of members of the Executive Committee.)

Child Welfare.

Civilian Coöperation in Combating Venereal Diseases.

Dentistry.

(With sub-committees on Dental and Oral Surgery, Dental Legislation and Enrollment, Dental Publicity, Dental Research, Examining Boards, Mobilizing Dental Educational Activities, Preparedness League of American Dentists, Special Hospitals,

Standardization of Dental Equipment and State Dental Societies.)

Editorial.

General Surgery.

(With sub-committees on Classification of Surgeons, Head Surgery, Ophthalmology, Otology, Laryngology and Rhinology.)

Hospitals.

Hygiene and Sanitation.

(With sub-committees on Alcohol, Drug Addiction, Public Health Nursing, Statistics, Tuberculosis, and Venereal Diseases.)

Industrial Medicine and Surgery.

Legislation.

Medical Advisory Board.

Medical Schools.

Nursing.

Publicity.

Research.

State Activities and Examinations.

Volunteer Medical Service Corps.

Women Physicians.

HOSPITAL NEEDS URGENT.

The following letter written by Dr. W. A. Brooks, acting surgeon-general of Massachusetts, setting forth the present need of hospital facilities has been forwarded to Surgeon-General Gorgas:

"With 100,000 going into action, and thousands more to follow, it is beyond comprehension that this country is not more alive to the fact that within a few weeks thousands of wounded may be coming home to be cared for.

I am informed that the intention of the Army Medical Corps is to send home only the wrecks, and to take care of the less severely wounded on the other side. No doubt the authorities in Washington think they see their way clearly to care for all the wounded in France, but to a man who has spent all of his life in hospitals, the thought occurs that perhaps such plans may have to be changed, and if they are changed, then truly the hospitals of New York, Boston and Baltimore will be proven to be utterly inadequate to handle the situation. They are not constructed on a large enough scale. We read that about 30 or 40% of 100,000 men means 30,000 wounded. It has been estimated that in the entire United States there are only about 150,000 hospital beds, and these are filled the greater part of the time. Massachusetts has a normal capacity of about 6000 beds. In an emergency about 3500 more can be furnished, and these are scattered all over the State.

The 6000 beds are practically full now. There are available, therefore, only about 3500 beds. A few good-sized shiploads of wounded and the available supply of beds will be exhausted. Within 12 months we may have over 1,000,000 men at the front. If so, taking the minimum number of normal casualties and adding 10% for those who are taken ill, and we will have a minimum of 300,000 or 400,000 men to be cared for. France and England are today overburdened with their own sick and wounded. Is it within reason that we can borrow hospital beds from them?

Another point. The three or four hundred thousand sick and wounded have to be fed. Is it a feasible plan to keep our wounded over there with cargo supply so limited? Does it stretch the imagination much to imagine the difficulties in keeping our fighting troops well supplied, and at the same time feed and care for three or four hundred thousand in the hospitals? The more sick and wounded who have to be cared for on the other side, the more difficult becomes the task of properly looking out for the fighting force. Our transports take our troops over. Are they coming back empty?

The objection has been raised that if the wounded are brought home, military authorities would never be able to get them back on the fighting line. Granted that this may be true (I for one do not think it is), there should be other trained men to take their places if the Army is going to be built on the scale it should be.

Assuming for the moment that only 10% of all the sick and wounded are brought back, how are the 30,000 or 40,000 going to be cared for? This country is now talking in billions. Not many months ago we were talking in millions, and not long before that we were talking in hundred thousands. Our hospitals are still in the hundred thousand class when they should, in order to keep up with the times, be in the billion. Hospitals of 2000 beds should be the rule, and not the exception, if we are to deal properly with the problems which must soon be met. Is America to fail to look after its sick and wounded? It surely will unless something is done and done quickly.

All the talk about putting wounded in private homes is all rubbish. It can be done, but who is going to look after them? In the city of Boston today every hospital is filled, and every hospital is short of skilled surgeons and physicians. Where are the doctors coming from to go from house to house?

It is only by concentrating the work, that there will possibly be found enough physicians and surgeons to care for the wounded properly. There ought to be under construction today near Boston a hospital with at least 2000 beds. It is not practical to think that any old building can be taken and converted into a hospital. Old buildings are not sanitary. Epidemics

would sweep through them. They are not supplied with proper plumbing. They are built up in the air and would be dangerous in case of fire.

The situation as it exists today demands immediate action, and I wish to go on record before the Public Safety Committee of Massachusetts as having stated the situation as it is, and as having stated the prospects of its soon becoming critical. I wish to go on record in regard to recommendations as to what in my opinion, should be done immediately."

Correspondence.

COMPULSORY ANTITYPHOID INOCULATION.

The following letter has been sent by Dr. Keen to the Secretary of War:

1729 Chestnut St., Philadelphia,
April 30, 1918.

HON. NEWTON D. BAKER, *Secretary of War*,
WAR DEPARTMENT, WASHINGTON, D. C.

My dear Mr. Secretary:—

In a four-page pamphlet entitled "Why is My Soldier Sick?" issued by the National Antivivisection Federation, Incorporated, with headquarters at 456 Fourth Avenue, New York City, are published two resolutions passed by the New York Antivivisection Society at its annual meeting, January 31, 1918, and forwarded to you officially. The second resolution reads as follows:

> "BE IT FURTHER RESOLVED: That a copy of the foregoing resolution be forwarded to the Secretary of War as our official protest against the medical department's claim that serum inoculation is a necessary war measure and for that reason made compulsory, and as our protest against compulsory inoculation when the individual soldier conscientiously objects thereto: and *we point to the provision of exemption now made by Great Britain, that power having been forced to rescind the rule of compulsion after the alarming effects of inoculation were disclosed.*" *

It has long been a matter of common knowledge and deeply regretted by the medical profession that Great Britain has never made antityphoid vaccination compulsory, as it fortunately is in our own army.

In an article entitled "The Red Cross and the Antivivisectionists," a copy of which I am enclosing, I have shown by irrefutable facts how extraordinary the protection of the antityphoid vaccination has been in our army and in the British army.

Although I knew that the statement in this Resolution was an absolute falsehood, I preferred to have an authority which was beyond all question. Accordingly, on Saturday, April 27, I sent the following cable to Surgeon General Goodwin, who occupies the same post in Great Britain that General Gorgas does in this country:

"*Surgeon General Goodwin,*
War Office, London.
Has antityphoid vaccination ever been compulsory in British army? KEEN."

To this, on Monday, April 29, I have received the following reply:

"London.
"*Prof. Keen, Philadelphia.*
"Antityphoid inoculation has never been compulsory in British army. GOODWIN."

You will observe, therefore, that this is a flat contradiction of the false assertion of the New York Antivivisection Society.

Nearly all of the British army has been voluntarily vaccinated against typhoid fever. Col. F. F. Russell, in Surgeon General Gorgas' office, authorizes me to say that he understands that 99% of the British soldiers are vaccinated against typhoid fever. The reason for this is that they have seen how extraordinarily complete is the protection offered by the antityphoid inoculation. At this time the fate of the war depends largely on the health of our army. It is, in my opinion, equivalent to disloyalty to deprive our soldiers of this protection and sacrifice their lives instead of the lives of a few rabbits, guinea-pigs, cats and dogs.

Yours very respectfully,
W. W. KEEN.

* Italics my own.

SOCIETY NOTICE.

NEW ENGLAND PEDIATRIC SOCIETY.—There will be a special meeting of the New England Pediatric Society at the Boston Medical Library, on Friday, May 24, 1918, at 8.15 P.M.

Dr. William Palmer Lucas, M.D., of San Francisco, Cal., Director of the Children's Bureau, Department of Civil Affairs, American Red Cross, will describe the work now being done for children in France. All physicians are invited to attend.

Light refreshments will be served after the meeting.

CHARLES HUNTER DUNN, M.D., *President*,
RICHARD H. SMITH, M.D., *Secretary*.

NOTICE.

PILOTS WANTED FOR NAVAL AVIATION SERVICE.—The aviation branch of the Naval Reserve Force has again opened. Young men between the ages of 20 and 25, who have two or three years college training, or its equivalent, will be accepted as applicants, provided they have a good knowledge of higher mathematics, trigonometry being absolutely essential.

These men will be given the provisional rating of chief quartermaster while under training for their commissions. The pay for chief quartermaster is $61.00 per month.

Only American citizens will be accepted. Men desiring to enroll in this branch should send a personal letter to Lieutenant J. K. Park, Jr., Room 1225, Little Building, Boston, Mass., who will mail applications and full information. No personal interviews will be given.

Men whose applications have been favorably considered will be ordered to active duty at once and receive their training at the Massachusetts Institute of Technology, Cambridge, Mass.

RECENT DEATH.

DR. D. FLETCHER INGALS, lecturer at the University of Chicago and a writer on medical topics, died in Chicago, as a result of angina pectoris. Dr. Ingals was an accepted authority on this disease, and in a recent issue of the *Journal of the American Medical Association*, he contributed an article describing his own experiences as a patient.